Essays on the Taxation of Multinational Enterprises under Profits and Losses

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To my family

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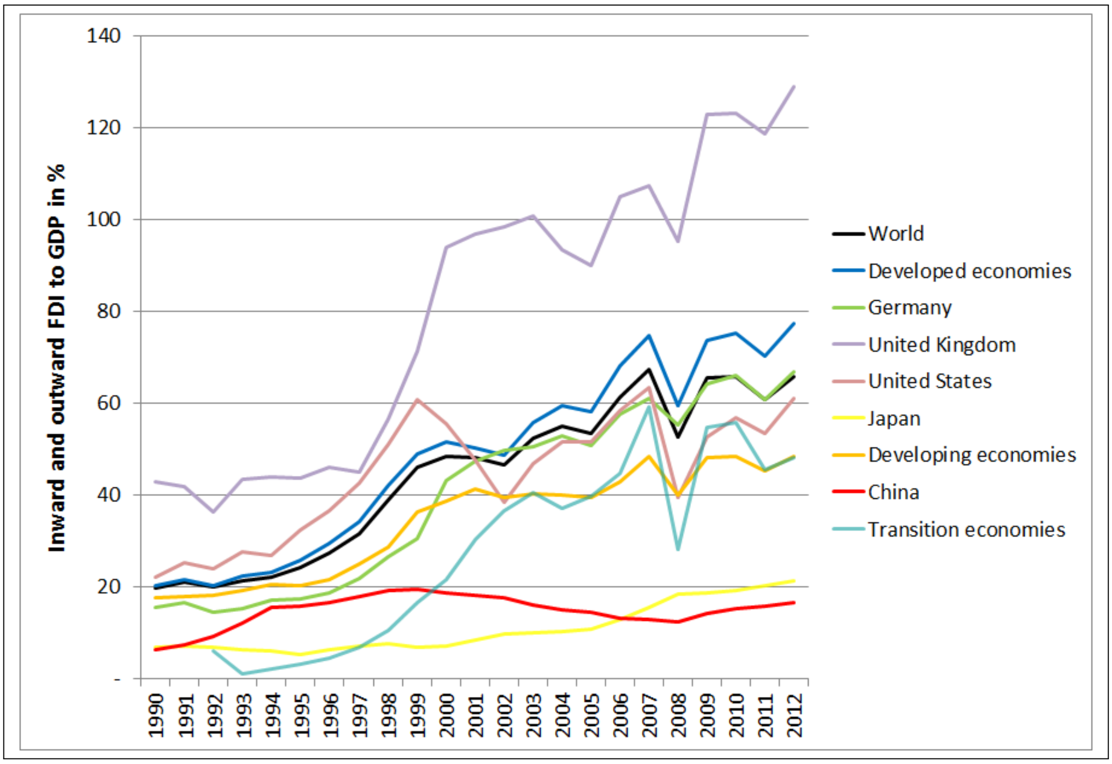
Preface

Over the last four decades, formal barriers to trade and capital have been substantially reduced which has fostered the international economic integration. Improvements in transportation and communication reduced firm's costs and enabled firms to start or expand foreign activities. One outstanding feature of this period is the increased flows of foreign direct investment (FDI). Figure 1 illustrates the sum of inward and outward FDI relative to gross domestic product (GDP) (FDI-to-GDP ratio) for selected countries and groups of countries during the period of 1990 to 2012. Within this period, the FDI-to-GDP ratio increased from 19.7% to 65.8% in the world, on average. In line with this observation, multinational enterprises became much more apparent over time. In the year 1993, the number of multinational parent corporations counted 37.000. These parent firms controlled over 200.000 foreign affiliates worldwide. By 2006 the number of parent firms increased to 78.000 with control of 778.000 foreign affiliates. Thus, the number of foreign affiliates per parent rose from 5.4 to 10.0, on average, indicating an wide-ranging dispersion of foreign activity.[1] This development is accentuated by Antràs (2003) who states that roughly one third of world trade is within firms. Kobetsky (2008) estimates that intercompany trade amounted to about 60% of world trade in 2006. These figures give a clear indication of the economic importance of multinational enterprises.

For governments there are many reasons why they want to attract FDI. The presence of multinational firms can lead to technology transfer and diffusion. Local firms can improve their productivity by copying multinational firms' technologies resulting, for example, in a higher rate of employment. In addition, entrance in the foreign market leads to more competition which forces local firms to use their resources more efficiently (Blomström and Kokko, 1998). Empirical studies also found that multinational enterprises pay higher wages to their employees (Feenstra and Hanson, 1997;

[1] See United Nations Conference on Trade and Development (UNCTAD) World Investment Reports 1994, 2007.

Figure 1: Total FDI stocks 1990-2012



Source: own illustration based on WIR 2013, Annex Table 07 and 08.

Girma et al. 2001). Apart from that the government has the opportunity to raise additional tax revenues from these firms.

For firms there are several determinants that are decisive for the location of FDI. Head et al. (1995) find that firms of the same industry tend to cluster in particular regions in order to profit from pecuniary and technological externalities, i.e. agglomeration effects. Head and Mayer (2004) use data on Japanese-owned affiliates to test whether market size has an effect on the location of FDI. They conclude that a 10% increase in market potential of a region increases the probability of that region to be chosen by 3% to 11%. Cheng and Kwan (2000) identify that, inter alia, good infrastructure and low wage costs have a positive effect on FDI. Furthermore, as governments are interested in collecting tax revenues, also a country's tax system plays an important role for firms.

Importantly, the tax system affects firms' decisions on three different stages.[2] First, once the firm decided to produce abroad, the effective average tax rate is the relevant measure for the firm in which country to set up a new affiliate as this captures the impact

[2]I neglect a prior decision in which firms choose whether to export or to produce abroad as tax considerations are immaterial at this stage, see, for example, Helpman et al. (2004).

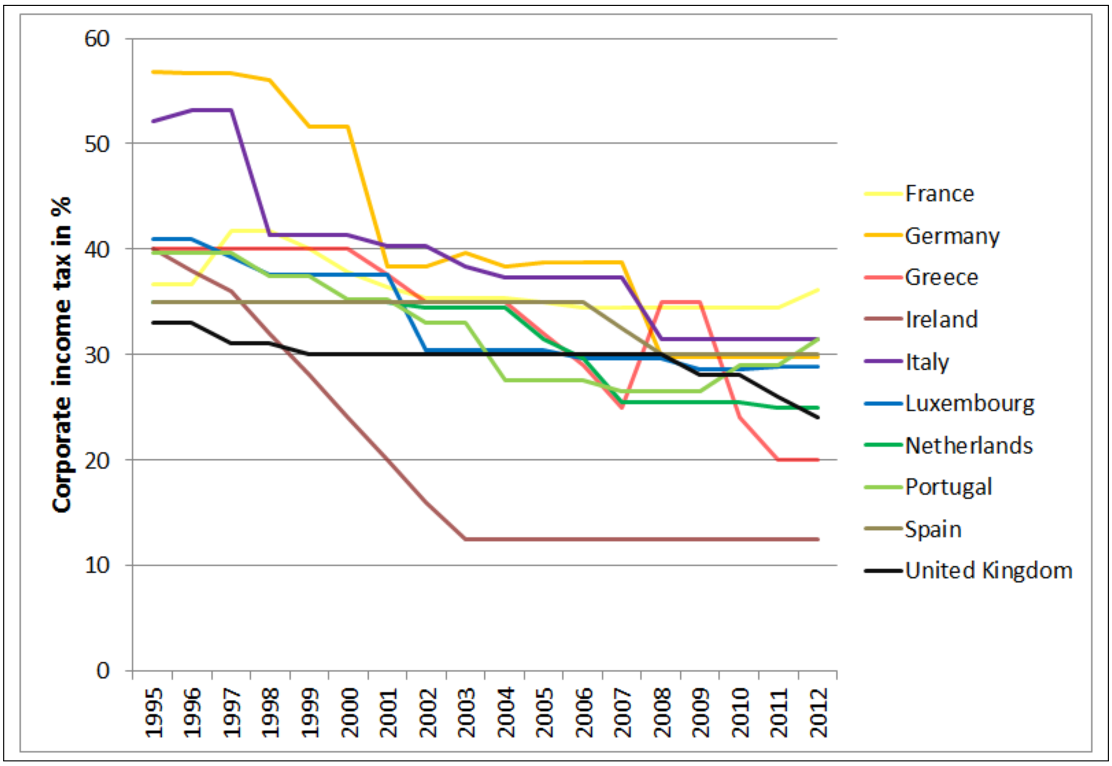
of the tax on total profits. Second, conditional on this decision, the firm chooses how much capital to invest. The optimal investment will be reached when the expected rate of return of the investment net of taxes is equal to the effective capital cost. It is therefore the effective marginal tax rate which is decisive. Third, conditional on the level of investment, the firm opts for the amount of realized profits it wants to report in the host country. At this stage, the statutory tax rate, precisely the difference in tax rates of the host country and the destination countries, i.e. those countries where profits are potentially shifted, is the important determinant for this decision of the firm. Thus, if firms react elastically to changes in these tax rate measures, countries have an incentive to compete against each other on all three dimensions.

There is empirical evidence that all three tax variables affect the firm's decisions. First, Devereux and Griffith (1998) find that a one percentage point increase in the effective average tax rate in the UK would lead to a reduction in the probability of a US firm choosing to produce there by around 1.3 percentage points. Second, Grubert and Mutti (1991) analyze the sensitivity of U.S. investors in 33 countries with respect to foreign effective tax rates. Their finding is that a reduction in the host country's tax rate from 20% to 10% increases U.S. affiliates' net plant and equipment in the country by 65%. Similarly, Hines and Rice (1994) show that a 1%-point reduction in the foreign tax rate is associated with approximately 3% greater use of capital by U. S. investors. Third, Clausing (2003) investigates the impact of tax influences on intra-firm trade prices. She finds that firms manipulate transfer prices in order to shift income into low-tax countries. Bartelsman and Beetsma (2003) suggest that at the margin more than 65% of the additional revenue from a unilateral tax increase is lost due to a decrease in the reported income tax base.

Based on these empirical findings it is very likely that countries have an incentive to beggar-thy-neighbor, i.e. to attract FDI, capital and profits at the cost of other countries by, for example, cutting their tax rates. There is a large body of contributions arguing that tax competition will lead to inefficiently low tax rates and public expenditure levels (Zodrow and Mieszkowski, 1986; Wilson, 1986; Wildasin, 1989; Bucovetsky and Wilson, 1991). These models have been extended in several ways. For example, Bucovetsky (1991) analyzes tax competition when countries differ in size; Brueckner (2000) investigates tax competition when labor is mobile within the country; Kind et al. (2005) analyze the effects of changes in the economic integration; Krautheim and Schmidt-Eisenlohr (2011) allow for heterogeneity of firms. However, the general message still remains that tax competition drives tax rates to an inefficiently low level.

Figure 2 displays changes in the corporate income tax rates in selected countries of the European Union. While all of these countries had tax rates above 30% in 1995, by 2012 seven out of the ten countries reduced their tax rates below 30%. The two countries with the most drastic decline in this period are Ireland and Germany. Those countries reduced their tax rate by 27.5%-points respectively 27%-points. A similar development can be observed by looking at the EU-27 countries. In the period from 1995 to 2013 statutory corporate tax rates fell from 35.3% to 23.2%, i.e. by 12.1 %-points, on average.[3] Empirically, Slemrod (2004) stresses that the corporate tax rate is insulated from a country's revenue needs and that the decline in corporate tax rates is due to international competitive pressures. Devereux et al. (2008) find that there is indeed a strategic interaction in the setting of corporate tax rates in the OECD countries. Although statutory tax rates and also the dispersion of corporate tax rates

Figure 2: Corporate income tax rates in selected EU countries 1995-2012



Source: own illustration based on Eurostat 2013 - Taxation trends in the European Union, Table 4.

have fallen since the 1980s[4], there is still a considerable variation across countries.

[3] See Eurostat 2013, Table 4.

[4] See table 1 in Slemrod (2004).

Figure 3 displays statutory corporate tax rates of 159 countries in the year 2013. Across the sample corporate tax rate vary from 0% on the Bahamas to 40% in the United States with an (unweighted) average rate of 23% and a median of 25% (Egypt). The existence of tax havens, e.g. Bahamas, Bahrain, Bermuda, British Virgin Islands, Cayman Islands, Jersey and the Maldives, which do not tax corporations at all, invites multinational firms to take advantage of the substantial tax differences. However, apart from these mostly small and affluent countries that impose a very low statutory tax rate, there are countries in Europe which introduced a preferential tax regime. By 2013, eleven countries have implemented an Intellectual Property Box regime, which grants a lower than statutory tax rate if firms locate their intellectual property in this country. Among these countries are Belgium (statutory tax rate: 33.99%, preferential tax rate: 6.8%), France (33.33%, 15.5%), Luxembourg (29.22%, 5.84%), Malta (35%, 0%), and Spain (30%, 15%) which generally have a very high statutory tax rate.[5]

Multinational firms can pursue several strategies to minimize their global tax payments. One strategy is to manipulate transfer prices by deviating from the true arm's-length price, i.e. the price at which two unrelated and non-desperate parties would agree to a transaction. Particularly, this strategy is attractive if the market price of the traded good is not observable which is true for patents, trademarks, brands and copyrights.[6] Another strategy is to shift profits via financial transactions. Precisely, affiliates in a low-tax country give loans to affiliates in high-tax countries in order to benefit from the interest depreciation tax shield.[7]

Governments try to combat profit-shifting by taking several actions. Almost all countries have included general anti-avoidance regulations mainly based on the arm's-length principle to their national tax law. In addition, some countries have also introduced specific transfer pricing regulations containing documentation requirements or the required disclosure.[8] However, for intangible assets there exists no market price. Therefore governments started also to implement controlled-foreign-corporation (CFC) rules. These CFC rule give governments the opportunity to tax resident multinationals' passive income if some conditions are met although the tax-exemption principle is applied. Additionally, the application of thin capitalization

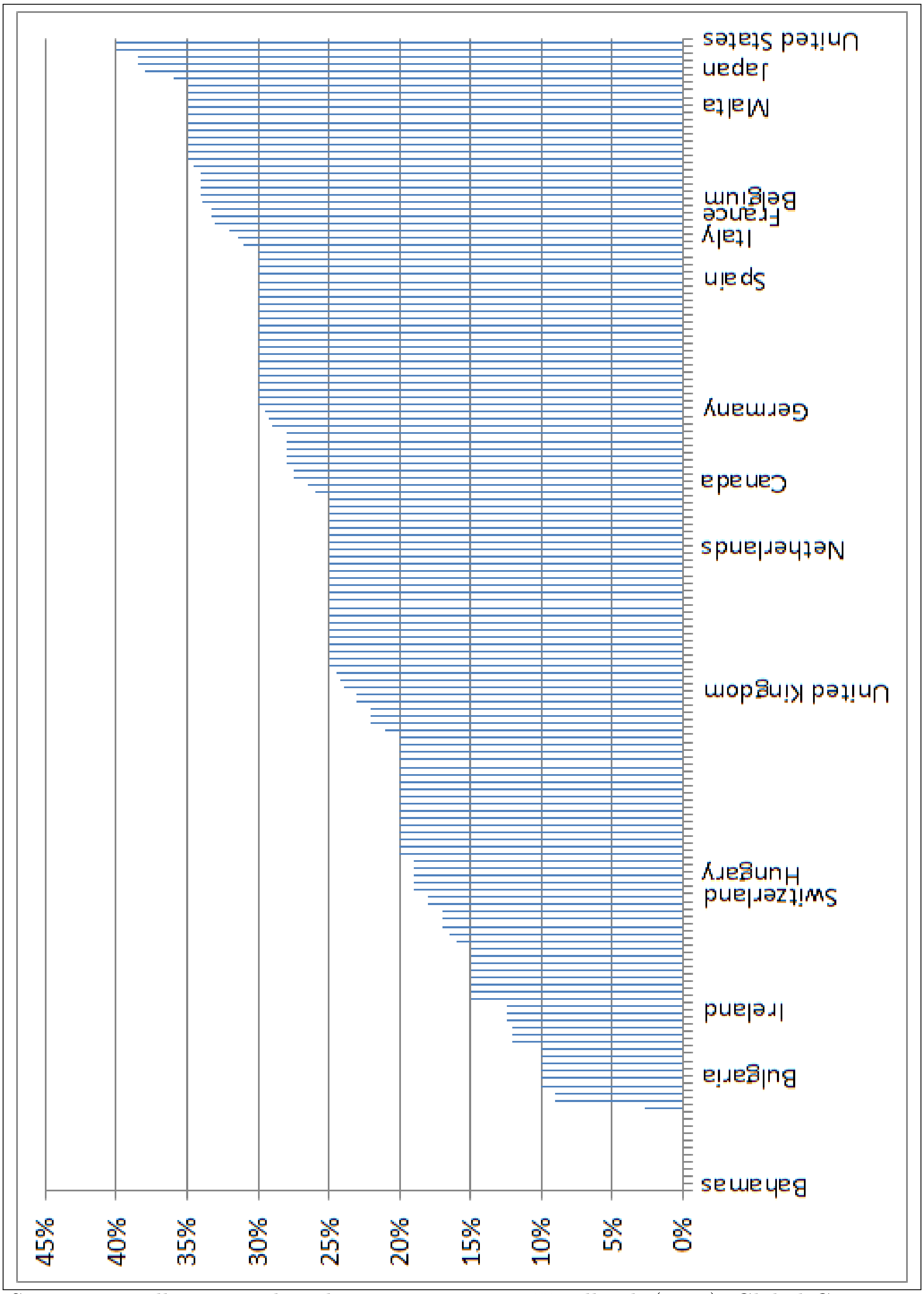
[5]For an overview of Intellectual Property Box regimes, see Evers et al. (2013).

[6]Between 1990 and 2012, royalties and license fee receipts increase by 770% from US $27 billion to US $235 billion, see UNCTAD World Investment Report 2013, table 2.

[7]Egger et al. (2010) find that foreign-owned firms on average exhibit a significantly higher debt ratio than their domestically owned counterparts in the host country.

[8]For an overview of Transfer Pricing Regulations, see Zinn et al. (2014)

Figure 3: Corporate tax rates 2013



Source: own illustration based on European Tax Handbook (2013), Global Corporate Tax Handbook (2013) and the Worldwide Corporate Tax Guide (2013) provided by Ernst & Young.

rules limit the amount of internal interest payments that is deductible for tax purposes to counter the incentive to change the financial structure just for tax reasons.

This dissertation consists of four chapters with focus on the effects of corporate taxation on the second and the third stage of firms' decisions. The first two chapters are concerned with governments actions against profit shifting. Chapter 1 considers optimal taxation of multinational firms and asks the question when CFC rules are part of the optimal tax mix. In contrast to chapter 1, chapter 2 analyzes the optimal thin capitalization rule under imperfect capital markets with heterogenous firms. Chapters 3 and 4 take different approaches. The center point of these chapters is the existence of corporate losses. In the absence of any possibility to offset losses against profits of other entities across the border, firms only have the options of carrying the losses backward or forward. According to Cooper and Knittel (2006) tax return data for U.S. corporations to investigate how firms use corporate tax losses. They find that approximately 25% to 30% percent of the losses are never used. In contrast to purely domestic firms multinational firms have a third option to use corporate losses. Alike with profits, they can just shift the losses to an affiliate that has a positive taxable income. Chapter 3 empirically tests this behavior and examines which strategies are more convenient. Chapter 4, again theoretically, focuses on the question of how the introduction of a coordinated form of cross-border loss relief will affect the governments' non-cooperative tax choices.

In the following, I will give a brief overview of the lines of argument developed in each chapter. All chapters a based on self-contained papers which can be read separately and are based on co-authored papers except for chapter 2.

Chapter 1 identifies the conditions under which binding controlled-foreign-corporation (CFC) rules are part of the optimal tax mix chosen by governments. By introducing CFC rules, the parent country of a multinational firm reserves the right to tax the income of the firm's foreign affiliates, if the tax rate in the affiliate's host country is below a specified threshold. This chapter shows that this is the case when the financial structure of the multinational firm responds elastically to the introduction of the CFC rule, outweighing the negative effects on the firm's investment decision in the parent country, and on the profits of the home-owned firm in the parent country's welfare objective. It also shows that if the government is mostly interested in maximizing tax revenues, a tighter CFC rule is associated with a tighter thin capitalization rule in its policy optimum. This chapter is based on unpublished work carried out jointly with Prof. Dr. Andreas Haufler, University of Munich, and Prof. Dr. Dirk Schindler, Norwegian School of Economics.

Chapter 2 analyzes the effects of thin capitalization rules when firms have limited access to external funding. In the absence of financial frictions, the purpose of thin capitalization rules is to limit multinational firms' possibilities to engage in tax planning via debt shifting. This chapter illustrates that governments choose more lenient thin capitalization rules when credit market frictions are severe. The analysis thus provides an explanation why financially less developed countries are more generous regarding the tax deductibility of internal interest payments. Furthermore, we show that an earnings stripping rule is more appropriate to solve the underlying policy conflict than a safe haven debt-to-equity ratio. Mardan (2014) is the basis of this chapter.

Chapter 3 studies the flexibility of multinational firms to revert their tax-avoidance mechanisms within a tax year, in order to shift in profits instead of shifting profits to low-taxed profit centers when running losses. Using data of Norwegian firms, this chapter shows that transfer pricing gives substantial flexibility to adjust profit shifting ex post (at the end of the tax-year). In contrast, there is no evidence for flexibility in the capital structure. Importantly, the chapter delivers an explanation for the puzzle, why estimated effects of tax incentives on the use of internal debt are so low. If firms are inflexible in adjusting their capital structure, i.e. they have to adjust their tax-management strategies ex-ante (at the beginning of the tax-year), it is the expected tax rate differential that is decisive and not the statutory tax differential. This chapter is based on unpublished work carried out jointly with Arnt O. Hopland, Ph.D., Norwegian School of Economics, and Prof. Dr. Dirk Schindler, Norwegian School of Economics.

Chapter 4 analyzes the effects of introducing a coordinated cross-border tax relief in a setting where multinational firms choose the size of a risky investment and host countries non-cooperatively choose tax rates. Following recent court rulings this has become a major policy issue in Europe. It shows that coordinated cross-border loss compensation may intensify tax competition when, following current international practice, the parent firm's home country bases the tax rebate for a loss-making subsidiary on its own tax rate. In equilibrium, tax revenue losses may thus be even higher than is implied by the direct effect of the reform. In contrast, tax competition is mitigated when the home country bases its loss relief on the tax rate in the subsidiary's host country. This chapter is based on joint work with Prof. Dr. Andreas Haufler, University of Munich (Haufler and Mardan, 2014).

Chapter 1

An economic rationale for controlled-foreign-corporation rules

1.1 Introduction

Controlled-foreign-company (CFC) rules have become an increasingly important policy instrument for governments in their attempt to curb profit shifting by multinational companies and to protect national corporate tax bases. CFC rules apply to so-called 'passive income' like interest payments and royalties which can easily be placed in affiliates in tax havens without having a substantial physical presence there.[1] By classifying an affiliate whose primary activity is to provide equity or patent services to other affiliates in the same corporate group as a 'controlled-foreign-corporation', the tax authority in the parent country of the multinational thus reserves the right to tax the profits of the affiliate in the tax haven by adding the affiliate's income in the tax haven to the profits declared in the parent country. CFC rules therefore override the tax-exemption principle that most countries now apply for the taxation of multinational firms.[2] Typically, CFC rules stipulate a minimum tax rate that must be levied

This chapter is based on joint work with Andreas Haufler and Dirk Schindler.

[1]See Dischinger and Riedel (2011) for evidence that patents are placed in low-tax countries and Reuters (2012) for a case study of tax avoidance in the United Kingdom.

[2]Under the tax-exemption method, the parent country does not tax the profits of foreign affiliates of a resident MNC. This scheme is applied by most OECD countries, with the prominent exception of the United States. See Becker and Fuest (2010) for a recent discussion and analysis.

in a host country, in order to avoid additional taxation in the parent country. In doing so, CFC rules reduce the tax gain for multinationals from placing valuable assets like equity or patents in a tax haven.

In recent years, there has been an active policy discussion surrounding CFC rules. In its so-called Cadbury-Schweppes decision, the European Court of Justice (ECJ) has tried to ban CFC rules for affiliates that operate within the European Economic Area and belong to multinationals that are headquartered in a European-Economic-Area country. At the same time, however, the OECD in its 'Action Plan on Base Erosion and Profit Shifting' calls for introducing and strengthening CFC rules in its member countries (OECD, 2013, action 3). Moreover, several recent empirical analysis (Ruf and Weichenrieder 2012; Egger and Wamser, 2011) have shown that CFC rules are effective in changing multinational firm's decision.

In the theoretical literature, however, CFC rules have so far been left out of the analysis of how governments respond to profit shifting by multinational firms. Importantly, the theoretical case for CFC rules is by no means clear. CFC rules only apply for domestic multinationals (i.e., multinationals that are headquartered in the country introducing the CFC rules), and they do not affect the activity of domestic affiliates of foreign-based multinationals. Hence, to protect the national tax base from both debt shifting and abusive transfer pricing, it should be better to enforce strict thin-capitalization rules. Thin capitalization rules restrict the amount of tax-deductible internal debt (i.e., borrowing from related affiliates) for domestic affiliates of both domestic and foreign multinationals and will therefore curb profit shifting in *all* multinational entities operating in the country. In contrast, CFC rules bind all affiliates worldwide of domestic multinationals only. Therefore, tight CFC rules reduce the foreign profits of domestic multinationals and provide (potentially) positive externalities on tax revenues in other countries. Hence, the question arises of why countries unilaterally implement such rules that seem to be inferior to thin-capitalization rules in protecting the national tax base, and which harm the foreign activities of domestic multinationals.

In this chapter, we identify the conditions under which binding CFC rules are part of the optimal tax mix chosen by governments. For this purpose we set up a model of two small countries and a continuum of tax havens which differ in their (exogenous) tax rates. The model has three types of firms, domestic firms, domestic multinationals, and foreign multinationals, all choosing their investment levels in the home country. The domestic and foreign multinationals in addition choose the tax-optimized financial structure of their investment. This implies that investments in the home country are financed by internal loans from an affiliate in the tax haven, provided that the interest cost of these loans are tax-deductible in the home country. The home country's government can tax all firms by means of the statutory corporate tax rate and can additionally use both a thin-capitalization rule and a CFC rule to control the choices of multinational firms.

Our analysis delivers the following results. In the tax policy optimum, the home government permits multinational firms to engage in some debt shifting to a tax haven, in order to reduce the effective cost of capital and increase investment by multinationals in the home country. This implies that some tax discrimination in favor of multinational firms will take place in equilibrium.[3] However, for any given level of internal debt permitted by the thin-capitalization rule, multinational firms will still have an incentive to engage in further, and costly, debt shifting to the tax haven. This incentive arises from the statutory tax rate differential between the home country and the tax haven, and cannot be affected by the thin-capitalization rules. Since lowering the statutory tax rate involves tax revenue losses from all firms, a binding CFC rule will be the preferred instrument to control this margin. A binding CFC rule will then result in the government's policy optimum, if the MNC's internal debt choice responds elastically to the introduction of the CFC rule, and if it outweighs the negative effects on the domestic MNC's investment decision and on the profits of its foreign affiliates.

We also analyze the relationship between the thin-capitalization rule and the CFC rule in the government's policy optimum. We show that a greater home bias of the domestic MNC leads to a tighter CFC rule and to a more generous thin-capitalization rule, if governments are mostly interested in maximizing tax revenues. The reason is that the domestic MNC's home affiliate reacts less elastic to changes in the effective capital costs. Thus, the government can be stricter in its CFC rule in order to reduce the excess leverage of the domestic MNC, without decreasing the investment too much. This incentive is strong if the profits shifted via excessive leveraging are large. Due to a decline in the excess leverage, the tax base of the domestic MNC's home affiliate increases which gives the government an incentive to be less strict in the thin capitalization rule in order to attract investments of all MNCs in the country. Again this effect is strong if the reduction in the excess leverage is large which corresponds to an initially high level of excess leverage.

[3]Note that, at least within the European Economic Area, thin-capitalization rules cannot be designed in a way to discriminate between domestic and foreign multinationals, see the Lankhorst-Hohorst ruling of the ECJ in 2002.

The existing literature on CFC rules is largely empirical. Egger and Wamser (2011) and Ruf and Weichenrieder (2012) analyze the effects of the German thin-capitalization rule on the investment and financing decisions of German multinationals. Ruf and Weichenrieder (2013) examine whether, and how, these patterns have been affected by the Cadbury-Schweppes decision of the European Court of Justice. To the best of our knowledge, the only theoretical contribution is Weichenrieder (1996). He analyzes the effect of CFC rules on capital investment and shows that CFC rules increase capital costs and decrease (foreign) investment of domestic multinationals. His analysis does not model debt shifting (nor transfer pricing) explicitly, however, and it does not derive optimal tax policies towards multinationals.

In comparison to CFC rules, thin-capitalization rules have received some more attention in the recent literature. From a theoretical perspective, Hong and Smart (2010) and Haufler and Runkel (2012) show that thin-capitalization rules can be used as an instrument to differentiate between the effective taxation of domestic and multinational firms. In a tax competition equilibrium, thin-capitalization rules will then be set inefficiently lax, in order to attract investment by multinational firms.[4] Mardan (2013) compares the effects of alternative thin-capitalization rules. From an empirical perspective, there is ample evidence that thin-capitalization rules are effective in restricting internal borrowing and debt shifting, but still offer sufficient leeway to allow for some (excessive) internal leverage. Examples of this literature are Weichenrieder and Windischbauer (2008), Overesch and Wamser (2010), Büttner et al. (2012), and Blouin et al. (2014).

The remainder of this chapter is organized as follows. In Section 1.2 we give some institutional background on CFC rules and describe the results in the recent empirical literature on this subject in more detail. Section 1.3 presents our model and derives the optimal financing and investment decisions of national and multinational firms. Section 1.4 turns to the optimal tax policy choices made by the small country's government. We also analyze in detail the relationship between the thin-capitalization and CFC rules chosen in the government's policy optimum. Section 1.5 discusses our results and outlines some possible extensions. Section 1.6 concludes.

[4] An analogous argument holds for a lax enforcement of the arm's-length-principle, which allows the MNC to shift profits to a low-tax haven. See Peralta and van Ypersele (2006).

1.2 Institutional background and empirical results

CFC rules were first introduced as 'Subpart F' legislation in the United States in 1964. Germany followed in 1972 ('Hinzurechnungsbesteuerung' in §§7 to 14 in the Foreign Tax Act) using the US rules as a blue print. In 2013, more than 30 countries worldwide used CFC rules to limit profit shifting by multinational corporations.[5] Table 1.1 collects the minimum tax rates that a host country must levy in order to avoid CFC taxation in the parent country of the multinational and compares this tax rate to the statutory corporate income tax rate in the parent country. The table also shows that most countries with CFC rules also employ thin-capitalization rules to limit debt-shifting by multinationals operating in their country.

The basic set-up of CFC rules is as follows. If a resident company (parent) has a significant, controlling influence (no matter whether direct or indirect shareholding) on an affiliate that is located abroad and faces a 'low tax rate', the host country of the parent will override the tax-exemption principle if the income is classified as 'passive income'. Passive income (e.g., interest income, royalties) will then be taxed on accrual under the tax-credit method at the higher tax rate of the parent company.

The German rules are exemplary. German CFC rules apply if a German company directly or indirectly holds 50% or more of the voting rights in a foreign affiliate and if this affiliates faces an effective tax rate of less than 25% (being calculated according to German tax base measures). If the foreign company earns passive income, that passive income is immediately included in the corporate tax base of the German parent company and taxed at the German tax rate – no matter where the passive income effectively accrued. Thereby, the German tax code negatively defines 'passive income' as not being listed as active incomes in §8(1) Foreign Tax Act. Essentially, passive income comprises revenues from nonproductive activities such as royalties and interest income in affiliates, earned on capital not raised from unrelated third parties.[6]

Due to the fact that the German central bank (i.e., Deutsche Bundesbank) provides a detailed data base (the so-called MiDi database) for analyzing debt-shifting, FDI flows and related issues, the German CFC rules are well-examined empirically. Ruf and

[5] See KPMG (2008) for a brief survey of institutional details. Lang et al. (2004) offer a detailed discussion of CFC rules from a legal perspective.

[6] For detailed overviews of the German CFC legislation, see Förster and Schmidtmann (2004) and Ruf and Weichenrieder (2012).

Table 1.1: CFC Rules and thin-capitalization Rules in Selected Countries (2013)

	corporate income tax rate (CIT, in%)	CFC rule: minimum tax in host country (%)	thin capitalization rule type[a]	ratio
Argentina	35	black-listed jurisdictions	debt/equity	2:1
Australia	30	30[b]	debt/equity	3:1
Azerbaijan	20	10 (50% of CIT)	none	-
Brazil	34	20 (as of 2015)	debt/equity	2:1
Canada	26.5	26.5[b]	debt/equity	2:1
China	25	12.5 (50% of CIT)	debt/equity	2:1
Denmark	25	25[b]	debt/equity	4:1
Egypt	25	18.75 (75% of CIT)	debt/equity	4:1
Finland	24.5	18.38 (75% of CIT)	interest/EBITDA	30%
France	33.33	16.66 (50% of CIT)	debt/equity	1.5:1
Germany	29.55	25	interest/EBITDA	30%
Hungary	19	10	debt/equity	3:1
Iceland	20	13.33 (66% of CIT)	none	-
Indonesia	25	25[b]	none	-
Israel	25	20	none	-
Italy	31.4	15.7 (50% of CIT)	interest/EBITDA	30%
Japan	38	20	debt/equity	3:1
Korea (Rep.)	24.2	15	debt/equity	3:1
Lithuania	15	11.25 (75% of CIT)	debt/equity	4:1
Mexico	30	22.5 (75% of CIT)	debt/equity	3:1
New Zealand	28	28[b]	debt/equity	1.5:1
Norway	28	18.66	none	-
Peru	30	22.5 (75% of CIT)	debt/equity	3:1
Portugal	25	15 (60% of CIT)	interest/EBITDA	30%
South Africa	28	21 (75% of CIT)	debt/equity	3:1
Spain	30	22.5 (75% of CIT)	interest/EBITDA	30%
Sweden	22	12.1 (55% of CIT)	none	-
Turkey	20	10	debt/equity	3:1
Un. Kingdom	23	17.25 (75% of CIT)	debt/equity	1:1
United States	40	40[b]	debt/equity	1.5:1
Uruguay	25	12	none	-
Venezuela	34	20	debt/equity	1:1

[a] 'Safe haven' debt-to-equity ratio or share of interest income over gross profits (EBITDA)up to which interest payments are deductible from the corporate tax base.

[b] Country adopts transaction approach: (only) the passive income of a CFC is added to the tax base in the residence country and taxed there, irrespective of the CFC's location.

Sources: European Tax Handbook (2013) and Global Corporate Tax Handbook (2013). International Bureau of Fiscal Documentation, Amsterdam.

Weichenrieder (2012) find that German CFC rules are very effective in curbing passive investments and have a strong impact on the location decision of internal banks and profit centers. Analyzing data from 1996 to 2006, the authors use a set of German tax reforms that occurred between 2001 and 2003.[7] One of their findings is that a shelter from CFC taxation has strong effects on the location of internal banks, i.e., conduit entities with positive net lending. The existence of binding CFC rules reduces the likelihood to locate the internal bank in such a low-tax country by 45%. Consequently, binding CFC rules significantly reduce passive investment in tax havens, and even lead multinationals to abandon their presence in some tax havens altogether.

In a sequel paper, Ruf and Weichenrieder (2013) test whether the Cadbury-Schweppes ruling by the ECJ in 2006 and the resulting ban of CFC rules for low-taxed affiliates within the European Economic Area induced German multinationals to relocate their profit centers and internal banks to (implicit) tax havens within the European Economic Area (e.g., Ireland or the Benelux countries). Analyzing the years 1999 to 2010 in the MiDi database, Ruf and Weichenrieder find (almost) no effect of the ECJ's decision. One explanation offered is that there is still sufficient uncertainty left whether CFC rules indeed no longer apply in countries of the European Economic Area. Another reason could be that the German multinationals had located their internal banks within the EU already before 2006.

Relying on the MiDi database as well, Egger and Wamser (2011) analyze the impact of German CFC rules on real investment (i.e., fixed assets) in foreign affiliates of German multinationals. These authors use the fact that the full set of German CFC rules (including exemptions) gives rise to two different thresholds, thus allowing for a two-dimensional regression discontinuity approach. Egger and Wamser find a substantially negative local average treatment effect (around the two treatment thresholds) on real investment, because a binding CFC rule significantly increases effective capital costs.

The only studies not using German data are Altshuler and Hubbard (2003) and Mutti and Grubert (2006). Altshuler and Hubbard look at US multinationals' income from financial services and rely on changes in the 'Subpart F' legislation in the Tax Reform Act of 1986. Their findings suggest that tighter US CFC rules restrict tax deferral by US multinationals. Mutti and Grubert, however, point out that there is an increased

[7] For example, there was a treaty override in 2003. Before 2003, passive income was sheltered from any taxation in Germany (and thus also from CFC legislation) in some double tax agreements, whereas other double tax agreements had explicit activity clauses providing tax shelter only for active income. In 2003, however, Germany decided to apply such activity clauses to *all* existing tax treaties.

use of hybrid entities that could allow US multinationals to work around the tightening of the US CFC rules.

1.3 The model

1.3.1 The basic framework

We set up a model of two small countries, a home country labeled h and a foreign country labeled f. Additionally, there exists a continuum of tax haven countries offering preferential tax rates t_k, which are continuously distributed in the range $[0, t_h)$. Capital is perfectly mobile across countries so that the rate of return of capital is fixed at $r > 0$.

There are two representative multinational companies (henceforth MNCs), one headquartered in each of countries h and f. Each MNC has one producing affiliate in each country, h and f respectively, and a financial center in one of the tax haven countries.[8] Furthermore, there is also one purely national firm in each country h and f. The categorization of firms into national vs. multinational firms is exogenous to our analysis, arising for example from differential fixed costs of setting up an 'internationalized' organizational structure.[9]

All firms use capital to produce a homogenous output good they sell in the world market at a price normalized to one. The output good is produced with capital and some fixed factor, leading to a production function with positive but decreasing returns to investment. Production technologies are allowed to differ between national firms and MNCs. For the national firms, the capital use is denoted by d_i, with $i \in \{h, f\}$, and production is given by $g(d_i)$. For the MNCs, capital use is k_i^j, where the superscript j denotes the ownership country (i.e., the country where the headquarter resides) and the subscript i indicates the country where capital is employed. Production by the MNCs is given by $f(\phi k_i^j)$. We assume a home bias where capital invested by a MNC in its home (headquarter) country is more productive than in the foreign (affiliate) country. One reasoning could be that agency problems in the home country are less

[8]We assume that all affiliates are fully owned by the parent company. For an analysis of debt shifting in the presence of variable ownership structures, see Schindler and Schjelderup (2012).

[9]This follows most of the literature on discriminatory tax competition, which assumes exogenous differences in the international mobility of capital tax bases. For an analysis that endogenizes the degree of firm mobility, see Bucovetsky and Haufler (2008).

severe so that less resources are lost or wasted. Hence, the productivity parameter is $\phi > 1$ if $i = j$, but $\phi = 1$ if $i \neq j$.

For simplicity, our analysis ignores external capital markets and assumes that all firms can raise sufficient equity to finance their optimal investment levels. Thus, all investment by national firms will be financed by equity. MNCs can, however, place their equity in the tax haven affiliate, which then makes internal loans to the affiliates in countries h and f. This generates interest income in the tax haven but deductible interest expenses in countries h and f, thus leading to aggregate tax savings by the MNC.

The governments of countries h and f can deploy three different tax instruments. These are (i) the corporate tax rates t_i; (ii) a thin-capitalization rule λ_i; and (iii) a CFC rule that is characterized by a minimum tax rate τ^j that the tax haven must levy to avoid taxation in the headquarter country j. These three policy instruments affect the decisions of MNCs by changing their effective tax rates. Thin-capitalization rules allow all MNCs investing in a host country i to deduct internal interest payments to the affiliate in the tax haven up to a maximum share $0 \leq \lambda_i \leq 1$ of the corporate tax base. The policy instrument λ_i may thus either capture a 'safe haven' ratio of debt to equity, or a share of total corporate profits (see Table 1.1). As long as the legally specified share λ_i is not exceeded, we assume that the internal loan transaction with the tax haven affiliate is not associated with any transaction costs for the firm. Hence, given the tax savings, affiliates will always find it optimal to engage in internal lending until the tax-deductible share of internal interest payments λ_i is exhausted.

Moreover, MNCs typically have additional ways to 'stretch' existing thin-capitalization rules, for example by utilizing holding structures that are allowed to have higher leverages (see Weichenrieder and Windischbauer, 2008, for details) or by misdeclaring internal debt as external debt and disguising the ownership in the internal bank.[10] Such restructuring will cause additional costs, however, which we call 'concealment costs' in the following. Hence, in excess of the tax-deductible share of internal debt λ_i that is covered by the thin-capitalization rule, affiliates will be able to deduct a further, endogenous share β_i^j of their capital costs in the host country by means of internal debt shifting to a tax haven. The share β_i^j is chosen so as to maximize the difference between the tax gain obtained by these additional transactions and the concealment costs incurred. Concealment costs are assumed to be a linear

[10] More generally, the results in empirical studies on thin-cap rules point to that there is always some leeway left; see, e.g., Blouin et al., (2014).

function of the capital stock and a quadratic function of the extra leverage β_i^j and are given by $C_i^j = (\delta/2)(\beta_i^j)^2 k_i^j$.

The CFC rule, in contrast, allows governments to discriminate between domestic and foreign MNCs, as only the domestic MNCs are affected by this rule. The tax rate τ^j is the minimum tax rate that a tax haven country must levy on the profits of the MNC in order to avoid additional taxation in the MNC's parent country (see Table 1). In the MNC's optimum, the affiliate holding the firm's capital (the 'internal bank' of the MNC) will therefore be located in a tax haven country k whose statutory tax rate t_k is just equal to this lowest possible tax rate that avoids the headquarter country j's CFC rules. Hence, by choosing τ^j, a headquarter country is able to limit the tax advantage that the domestic MNC obtains from internal leverage. This instrument thus applies to both the internal debt within the limit of the legally stipulated thin-capitalization rule, and to the firm's optimal level of 'excess' leverage β_i^j.

1.3.2 Firms' decision problems

National firms. Unlike MNCs, the national firms do not have the opportunity to use internal debt as a tax planning instrument. Costs of capital cannot be deducted from the tax base and hence the tax combines a tax on profits with a 'pure' capital tax. The decision problem of the national firms reduces to an investment decision problem. Profits of the national firms are

$$\pi_i^d = (1 - t_i)g(d_i) - rd_i. \tag{1.1}$$

The optimal investment level is then implicitly defined by the first-order condition

$$(1 - t_i)g'(d_i) = r. \tag{1.2}$$

The effects of an increase in the statutory tax rate t_i on the investment levels of national firms are given by

$$\frac{\partial d_i}{\partial t_i} = \frac{g'(d_i)}{(1 - t_h)g''(d_i)} < 0 \qquad \forall\, i \in \{h, f\}. \tag{1.3}$$

Since the costs of financing the investment are not tax-deductible for national firms, but the returns from the investment are taxed, a higher tax rate induces national firms to reduce their investment levels. The governments' remaining tax instruments do not affect national firms.

Multinational firms. Under the ruling international standard of separate accounting, profits are considered separately for each entity of a MNC. Moreover, for a firm that is headquartered in country j and has an affiliate in country i, net profits are

$$\pi_i^j = (1 - t_i) f(\phi k_i^j) - \rho_i^j k_i^j, \tag{1.4}$$

where $\phi \geq 1$, as discussed above and the firm-specific capital costs are

$$\rho_i^j = \left[1 - (t_i - \tau^j)(\lambda_i + \beta_i^j) + \frac{\delta}{2r}(\beta_i^j)^2\right] r. \tag{1.5}$$

Thus the capital costs of an affiliate of MNE j in country i are reduced by the tax shield of internal debt, which depends on the host country's tax rate t_i. However, the tax gain is limited by the fact that the headquarter country's CFC rule leads to the internal bank being located in a tax haven with the tax rate τ^j (where the interest income from the internal loan is taxed).[11] The amount of internal debt that is shifted to the tax haven depends on the share of internal debt λ_i that is tax-deductible under the thin-capitalization rule, and on the excess leverage β_i^j. The latter, however, causes concealment costs that reduce the net gain from the extra leverage β_i^j and increase the capital cost.[12]

The MNC's maximization problem can be seen as a two stage process where the affiliate first chooses the profit maximizing financial structure and then, in a second step, decides on how much to invest and produce in each country. The optimal leverage ratio is obtained by minimizing the effective capital cost in (1.5) with respect to β_i^j, giving

$$\beta_i^j = \frac{r}{\delta}(t_i - \tau^j). \tag{1.6}$$

Substituting (1.6) in (1.5) gives the effective capital cost under the optimized financial

[11]For a tax-efficient capital structure, the internal debt tax shield needs to be maximized. That implies to place the internal bank in the affiliate with the lowest effective tax rate; see Mintz and Smart (2004) and Schindler and Schjelderup (2012). In case of CFC rules, this affiliate will be the one for which the CFC rule is just not binding.

[12]From (1.5) we see that the investment costs of an affiliate in country i would be fully tax-deductible, leading to effective capital costs $\rho_i^j = (1 - t_i)r$, if the headquarter country allowed the internal bank to be placed in a tax haven with a zero tax rate ($\tau^j = 0$) and there is no binding thin-capitalization rule so that $\lambda_i = 1$. In this case the affiliates would not have an incentive to use any extra leverage ($\beta_i^j = 0$) and consequently would also not occur any concealment costs.

structure

$$(\rho_i^j)^* = \left[1 - (t_i - \tau^j)\lambda_i - \frac{r}{2\delta}(t_i - \tau^j)^2\right] r. \tag{1.7}$$

From equation (1.7) we can derive the effects of all tax instruments on the effective capital costs of each affiliate. In country h, three different entities of MNCs need to be considered: the home affiliate of the domestic MNC, the foreign affiliate of the domestic MNC, and the home affiliate of the foreign MNC. The effect of the home country's tax parameters t_h, λ_h and τ^h on these three firm types are given by

$$\frac{\partial \rho_h^h}{\partial t_h} = -(\lambda_h + \beta_h^h)r, \quad \frac{\partial \rho_h^h}{\partial \lambda_h} = -(t_h - \tau^h)r, \quad \frac{\partial \rho_h^h}{\partial \tau^h} = (\lambda_h + \beta_h^h)r; \tag{1.8a}$$

$$\frac{\partial \rho_f^h}{\partial t_h} = 0, \quad \frac{\partial \rho_f^h}{\partial \lambda_h} = 0, \quad \frac{\partial \rho_f^h}{\partial \tau^h} = (\lambda_f + \beta_f^h)r; \tag{1.8b}$$

$$\frac{\partial \rho_h^f}{\partial t_h} = -(\lambda_h + \beta_h^f)r, \quad \frac{\partial \rho_h^f}{\partial \lambda_h} = -(t_h - \tau^f)r, \quad \frac{\partial \rho_h^f}{\partial \tau^h} = 0. \tag{1.8c}$$

Turning first to the effects on the domestic MNC's home affiliate in (1.8a), we see that an increase in country h's statutory tax rate lowers the effective capital costs, because it increases the tax shield of (internal) debt. Similarly, a more lenient thin-capitalization rule reduces the cost of capital by decreasing the corporate tax base. Finally, an increase in τ^h, which implies a tightened CFC rule, decreases the gains from debt shifting and therefore results in higher effective capital costs.

The tax effects on the home MNC's affiliate in the foreign country f are given in (1.8b). This shows that neither the statutory tax rate t_h nor the thin-capitalization rule λ_h affects the effective capital costs of this affiliate. However, country h's CFC rule applies to the domestic firm's affiliate in the foreign country. Thus, an increase in τ^h increases the effective capital costs of this affiliate.

Finally, equation (1.8c) shows the tax effects on the foreign MNC's affiliate in the home country h. An increase in the home country's statutory tax rate t_h or the thin-capitalization rule λ_h reduces the effective capital costs for the foreign MNC for the same reasons as they are true for the domestic MNC [see eq. (1.8a)]. However, the foreign MNC is unaffected by a change in the home country's CFC rule τ^j.

In the first stage, all MNCs choose their investment levels, given the optimized financial structure. From (1.4), optimal investment levels are

$$(1 - t_i)\phi f'(\phi k_i^j) - \rho_i^j = 0 \qquad \forall\, i, j = h, f. \tag{1.9}$$

An increase in the effective capital costs ρ_i^j decreases investment by

$$\frac{\partial k_i^j}{\partial \rho_i^j} = \frac{1}{(1-t_i)\phi^2 f''(\phi k_i^j)} < 0 \qquad \forall\, i, j = h, f. \tag{1.10}$$

The effects of the home country's statutory tax rate t_h on the investment decision of each MNC result from the direct effects on net profits in (1.9) and the effect on the effective capital costs in (1.8a)–(1.8c). Recalling that $\phi > 1$ if $i = j$, but $\phi = 1$ if $i \neq j$ gives

$$\frac{\partial k_h^h}{\partial t_h} = \frac{\phi f'(\phi k_h^h) - (\lambda_h + \beta_h^h)}{(1-t_h)\phi^2 f''(\phi k_h^h)} < 0, \qquad \frac{\partial k_f^h}{\partial t_h} = 0, \qquad \frac{\partial k_h^f}{\partial t_h} = \frac{f'(k_h^f) - (\lambda_h + \beta_h^f)}{(1-t_h) f''(k_h^f)} < 0. \tag{1.11}$$

Accordingly, the statutory tax rate t_h negatively affects investment levels for all affiliates located in country h, but not the investment of the foreign affiliate of the domestic MNC. The investment effects of the other tax instruments λ_h and τ^h result only from the changes in the effective cost of capital (1.8a)–(1.8c), in combination with the negative effect of capital costs on investment levels in (1.10).

1.4 Optimal tax policy

Welfare in country h is given as a weighted average of domestic tax revenues and the sum of the profits of national firms and the domestic MNC,[13]

$$W_h = t_h \cdot T_h + \gamma \cdot \Pi^h, \tag{1.12}$$

where T_h is the total tax base in the home country, $\Pi^h = \pi_d + \pi_h^h + \pi_f^h$ are the total profits of firms operating in h, and $0 \leq \gamma \leq 1$ is the relative welfare weight placed on firms' profits. The welfare discount on firms' profits either reflects the fact that raising corporate tax revenue is important for society (either for redistributive reasons, or to reduce other distortive taxes), or that domestic firms are partly owned by foreign investors that do not enter the domestic welfare function. For $\gamma = 0$ we would have a Leviathan government that is solely interested in maximizing its tax revenue.

The domestic tax base T_h consists of the sales of all entities located in country h. From this is subtracted the tax cost for the government of granting a tax shield by permitting

[13]Note that consumers in the home country are not affected by tax policy in our model, because the price of the single output good is determined in the large world market.

the deduction of internal debt for the home affiliates of the domestic and the foreign MNCs:

$$T_h = g(d_h) + f(\phi k_h^h) - \left[\lambda_h + \frac{r}{\delta}(t_h - \tau^h)\right] r k_h^h + f(k_h^f) - \left[\lambda_h + \frac{r}{\delta}(t_h - \tau^f)\right] r k_h^f, \quad (1.13)$$

The home government (and analogously the foreign government) maximizes national welfare in (1.12) by choosing the statutory tax rate t_h, the thin-capitalization rule λ_h and the CFC rule τ^h, subject to the optimal financing and investment decisions of the different firm types as discussed in the last section.

1.4.1 Choosing individual tax parameters

Optimal statutory tax rate. The welfare function shows that all types of firms in country h are affected by changes in the statutory tax rate. Differentiating the welfare function with respect to t_h implicitly determines the optimal statutory tax rate:

$$\begin{aligned}
\frac{\partial W_h}{\partial t_h} &= (1-\gamma)\left[g\left(d_h\right) + f\left(\phi k_h^h\right) - \left(\lambda_h + \beta_h^h\right) r k_h^h\right] + \left[f\left(k_h^f\right) - \left(\lambda_h + \beta_h^f\right) r k_h^f\right] \\
&+ t_h g'(d_h)\frac{\partial d_h}{\partial t_h} + t_h\left[\phi f'\left(\phi k_h^h\right) - \left(\lambda_h + \beta_h^h\right) r\right]\frac{\partial k_h^h}{\partial t_h} \\
&+ t_h\left[f'(k_h^f) - (\lambda_h + \beta_h^f) r\right]\frac{\partial k_h^f}{\partial t_h} - t_h\frac{r^2}{\delta}\left(k_h^h + k_h^f\right) = 0. \qquad (1.14)
\end{aligned}$$

The first-order condition in (1.14) states that an increase in the statutory tax rate t_h increases the welfare in country h due to higher net gains from taxing domestic profits (the first term on the right-hand side) and from the taxation of foreign-owned profits (the second term). However, a higher statutory tax rate also reduces the domestic tax base, and hence tax revenues, as a result of lower investments by all local affiliates (the third, fourth and fifth term). Finally, the tax base of country h is further reduced because MNC affiliates in country h have an incentive to increase the variable internal debt level β_i^j (the sixth term).

Evaluating (1.14) at $t_h = 0$ shows that all negative terms are zero in this case and hence $\partial W_h/\partial t_h$ is unambiguously positive at this point. Therefore, the statutory tax rate must be positive in the government's optimum.

Optimal thin-capitalization rule. Introducing a thin-capitalization rule allows the government to discriminate between purely national and MNCs, by changing the tax base for MNCs. Differentiating (1.12) with respect to λ_h gives

$$
\begin{aligned}
\frac{\partial W_h}{\partial \lambda_h} &= t_h \left[\phi f'\left(\phi k_h^h\right) - \left(\lambda_h + \beta_h^h\right) r\right] \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \lambda_h} \\
&+ t_h \left[f'\left(k_h^f\right) - \left(\lambda_h + \beta_h^f\right) r\right] \frac{\partial k_h^f}{\partial \rho_h^f} \frac{\partial \rho_h^f}{\partial \lambda_h} - t_h r \left(k_h^h + k_h^f\right) \\
&- \gamma k_h^h \frac{\partial \rho_h^h}{\partial \lambda_h} \leq 0. \qquad (1.15a)
\end{aligned}
$$

The first two terms on the right-hand side of (1.15a) is positive, as an increase in λ_h reduces the effective capital costs and thus induces the home affiliates of the domestic and foreign MNCs to expand their investment, and thus their sales in the home country [see (1.10)]. The third term is negative, however, as a more generous thin-capitalization rule allows MNCs to deduct a higher share of their financing costs from the corporate tax base. Finally, the fourth term is again positive, as a reduction in its capital costs increases the profits of the domestic MNC's home affiliate.

From (1.15a) we can infer that the government will only set a positive level of λ_h in the optimum, if the three positive effects overcompensate the negative third effect. This will be the case when the affiliates' investment in country h reacts strongly to changes in the cost of capital (i.e., $\partial k_h^h / \partial \rho_h^h$ and $\partial k_h^f / \partial \rho_h^f$ are large in absolute value), or when the profits of the domestic MNC's home affiliate are important (large γ). When these conditions are met, we can rewrite (1.15a) as

$$
\begin{aligned}
\lambda_h t_h r \left(k_h^h + k_h^f\right) &= \frac{t_h}{(1-t_h)} \left[k_h^h \mu^h \varepsilon_{k_h^h, \rho_h^h} \varepsilon_{\rho_h^h, \lambda_h} + k_h^f \mu^f \varepsilon_{k_h^f, \rho_h^f} \varepsilon_{\rho_h^f, \lambda_h}\right] \\
&- \gamma k_h^h \rho_h^h \, \varepsilon_{\rho_h^h, \lambda_h} \qquad (1.15b)
\end{aligned}
$$

where $\mu^j = \rho_h^j - (1-t_h)(\lambda_h + \beta_h^j)\, r > 0$ and we have defined the elasticities

$$
\varepsilon_{k_h^j, \rho_h^j} = \frac{\partial k_h^j}{\partial \rho_h^j} \frac{\rho_h^j}{k_h^j}, \qquad \varepsilon_{\rho_h^j, \lambda_h} = \frac{\partial \rho_h^j}{\partial \lambda_h} \frac{\lambda_h}{\rho_h^j}, \qquad j = \{h, f\}. \qquad (1.16)
$$

The first expression in (1.16) is the elasticity of capital with respect to the effective capital costs. The second expression gives the elasticity with which the effective cost of capital of the domestic and the foreign MNC respond to the home country's thin-capitalization rule.

Using (1.15b), we can interpret how the optimal (positive) thin-capitalization rule is affected. Clearly, the optimal level of λ_h is the larger the higher is the product of the elasticities $\varepsilon_{k^j_h,\rho^j_h}\varepsilon_{\rho^j_h,\lambda_h}$. The product of these elasticities rises, in turn, when $f''(\phi k^h_h)$ and $f''(k^f_h)$ are small [see eq. (1.10)]. This implies that pure profits are low and the tax is mostly a tax on the normal return to capital. If capital reacts very elastically to changes in the thin-capitalization rule ($\varepsilon_{k^j_h,\rho^j_h}\varepsilon_{\rho^j_h,\lambda_h} \to \infty$), then λ_h must go towards its maximum of one. In this case the investment expansion will always dominate the tax base reduction caused by the larger tax shield.

Optimal CFC rule. Finally, the home government can set a minimum statutory tax rate τ^j for an affiliate of the domestic MNC located in a tax haven, where τ^j is just sufficient to avoid additional taxation in the home (headquarter) country. Thus, the CFC rule reduces the tax gain from internal debt and consequently raises the cost of capital for affiliates of the domestic MNC located in h and f. Differentiating (1.12) with respect to τ^h gives

$$\begin{aligned}\frac{\partial W_h}{\partial \tau^h} &= t_h\left\{\frac{r^2}{\delta}\,k^h_h + \left[\phi f'\left(\phi k^h_h\right) - \left(\lambda_h + \beta^h_h\right) r\right]\frac{\partial k^h_h}{\partial \rho^h_h}\,\frac{\partial \rho^h_h}{\partial \tau^h}\right\}\\ &- \gamma\left[k^h_h\left(\lambda_h + \beta^h_h\right) + k^h_f\left(\lambda_f + \beta^h_f\right)\right] r \leq 0. \qquad (1.17a)\end{aligned}$$

The first term in the curly bracket on the right-hand side is positive, showing that a tighter CFC rule increases tax revenues in the home country by reducing the extra leverage β^h_h that the home affiliate of the domestic MNC chooses in its financial optimum. In contrast, the second term in the curly bracket is negative, because a tighter CFC rule increases the effective capital costs of the domestic MNC's home affiliate, thereby reducing investment and tax revenues. Finally, the third term is also negative as all affiliates of the domestic MNC lose profits due to the higher costs of capital.

Again, the government will only implement a CFC rule if the welfare gains associated with this instrument exceed the welfare losses. This is the case if the concealment cost parameter δ is low and hence internal debt responds elastically to changes in the CFC rule. Moreover, a positive CFC rule is more likely, other things being equal, if the investment response of the domestic MNC's home affiliate is inelastic and if tax revenues have a high weight in the welfare function, relative to the profits of the home MNC (γ is small). We summarize these conditions in:

Proposition 1.1 *Each government sets a binding CFC rule in its optimum* ($\tau^h >$ 0)*, if* (*i*) *the financing structure of the domestic MNC responds elastically to this policy change,* (*ii*) *the investment decision responds inelastically to the rise in the cost of capital; and* (*iii*) *if tax revenue is important, relative to the domestic MNC's* *profits.*

If the conditions in Proposition 1.1 are met, we can rewrite (1.17a) as

$$\tau^h \left\{ \gamma \left[1 + \frac{k_f^h \left(\lambda_f + \beta_f^h\right)}{k_h^h \left(\lambda_h + \beta_h^h\right)} \right] - \frac{t_h}{1-t_h} \frac{\mu^h}{\rho_h^h} \, \varepsilon_{k_h^h, \rho_h^h} \right\} = -t_h \, \varepsilon_{\beta_h^h, \tau^h}, \tag{1.17b}$$

where

$$\varepsilon_{\beta_h^h, \tau^h} = \frac{\partial \beta_h^h}{\partial \tau^h} \frac{\tau^h}{\left(\lambda_h + \beta_h^h\right)}.$$

From (1.17b), we can infer how the optimal (positive) CFC rule is affected. Firstly, the CFC rule is the larger the smaller is the foreign investment of the domestic MNC (k_f^h), relative to its home investment (k_h^h). This is because the CFC rule increases the cost of capital for all affiliates of the domestic MNC. This increases the tax base of the home affiliate, resulting in lower profits of the domestic MNC but also in higher tax revenues. In contrast, the tax base broadening of the foreign affiliate reduces the domestic MNC's profits but the additional tax payments accrue to the foreign country f. Secondly, if profits of the domestic MNC are unimportant for welfare (γ is small) the negative effect of a decrease in the domestic MNC's profits is small. This leads to a tighter CFC rule (a higher level of τ^h), other things being equal. Thirdly, the CFC rule is the larger, the smaller is $\varepsilon_{k_h^h, \rho_h^h}$ in absolute value. This implies that domestic investment does not fall too much if capital costs are increased. From (1.10) we see that the investment response is reduced if there are high profits in the home market (f'' is large), or if there is a large home bias of the domestic affiliate (ϕ is large).

1.4.2 Comparative statics

So far, we have discussed each policy instruments in isolation. It is interesting to see, however, whether the choice of the optimal thin-capitalization rule on the one hand and the optimal CFC rule on the other are interrelated. Therefore, we analyze how a change in the home bias parameter ϕ affects the optimal thin capitalization rule λ_h and the optimal CFC rule τ^h. In appendix A, we can show that

Proposition 1.2 *A higher home bias corresponds with a tighter CFC rule (a higher level of τ^h) and with more generous thin-capitalization rule (a higher level of λ_h) if the government maximizes tax revenues and δ is small.*

The intuition is as follows. The direct effect of an increase in the home bias is that the domestic MNC's home affiliate reacts less sensitive to changes in the effective capital costs (cf. (A.16)). Other things being equal, the government has an incentive to set a stricter thin capitalization rule and a tighter CFC rule. The reason is that the government's tax gains from relaxing the thin capitalization rule are reduced due to the lower elasticity of investments of the domestic MNC's home affiliate. For the same reason, the government can implement a tighter CFC rule as the reduction in investment due to an increase in the effective capital costs are smaller.

However, for each of the two policy instruments there exists a counteracting indirect effect which would be absent if we looked at the policy instruments in isolation. A stricter CFC rule reduces the domestic MNC's incentive to shift profits as the tax differential, i.e. the difference between the home country's tax rate and the tax rate in the pivotal tax haven country (whose tax rate is just high enough to avoid CFC legislation) is reduced. This increases the tax base of the domestic MNC's home affiliate and allows the home government to be more generous in the thin capitalization rule. This effect is stronger the higher the initial amount of the excess leverage β_h^h. Thus, if costs of concealing are low, that is if δ is small, this effect will overcompensate the direct effect. Consequently, the government allows a higher amount of tax deductions for internal interest payments if the home bias increases.

A more lenient thin capitalization rule counters the decrease in the elasticity of investment and thus increases the costs of the CFC rule (see second term in in curly brackets of (1.17a)). However, as a less strict thin capitalization rule increases investments also the amount of profits shifted via excessive leveraging rises (see first term in curly brackets of (1.17a)) which can be taxed by the CFC rule. These tax revenue gains are higher, the higher the initial excess leverage and thus the smaller the costs of concealing. Hence, if δ is small, the increase in tax revenues via a reduction in the excess leverage will overcompensate the decline in investments induced by tightening the CFC rule. As a result, the government will set a tighter CFC rule in the optimum if the home bias increases.

1.5 Discussion and extensions

In the previous section, we have discussed the conditions under which countries choose positive values of λ_h and τ^h. This requires that the MNC's financing decision responds very elastically to tax incentives, the investment elasticities of MNCs have an intermediate value, and the governments are mostly interested in tax revenues. For many countries this seems to be a plausible combination of parameters, motivating the existence of CFC rules and a positive share of internal debt that is deductible from the corporate tax base (see Table 1.1).

We can go one step further, however, and interpret the optimal policies quantitatively for different country characteristics. For example, the optimal level of the thin-capitalization rule λ_h in (1.15b) will be higher, if a country faces a high elasticity with which investment from domestic and foreign MNCs responds to changes in the cost of capital. Such high investment elasticities are typical for small countries, for example. Therefore, the first-order condition (1.15b) is compatible with the result that smaller countries will have more lenient thin-capitalization rules, on average, than their larger (and otherwise similar) neighbors.[14] Alternatively, a high investment elasticity can also be the result of small location rents to be earned in a given country. This corresponds to a low value of $f''(k_i^j)$ in eq. (1.10). Thus, in another interpretation, our results are compatible with the finding that countries offering few location rents will have more generous thin-capitalization rules, on average (see Mardan, 2014).

Similarly, we see from (1.17b) that the optimal CFC tax rate τ^h is smaller when the ratio of foreign over domestic investment is high (i.e., k_f^h/k_h^h is large). This is because the foreign affiliates of the domestic MNC suffer from income losses when the CFC rule is tightened, but the tax revenues resulting from the higher effective tax rate accrue to the foreign host countries. This suggests that CFC rules will be used primarily by large countries, whose MNCs have a substantial presence in the home country. This is consistent with the evidence presented in Table 1.1.

We can also outline some possible extensions of our analysis. Our specification of CFC rules has focused on the minimal tax rate t_k that a (tax haven) host country must levy in order to circumvent additional taxation by the headquarter country of the MNC. A second criterion of CFC rules is that the income earned earned in the tax haven country must be 'passive income'. Therefore MNCs could alternatively avoid the CFC rule, if they adjusted their activities in the tax haven so that the income is classified as active income. The CFC rule would then not bind, even if the tax rate in the host country is below the critical threshold. With such an extension, MNCs could therefore engage in costly strategies to turn passive into active income, in order to increase the tax gain of internal debt. This additional avoidance decision would thus tend to make a given CFC rule less effective as an instrument to increase tax revenue collections. However,

[14] See Haufler and Runkel (2012, Proposition 4) for a rigorous analysis of this case.

as long as setting up a substantial physical presence in the tax haven is costly to the firm, the qualitative effects of introducing CFC rules should remain unchanged.

Finally, our model currently assumes that MNCs have no costs of placing an affiliate in a tax haven and face no transaction cost of shifting internal debt there (at least for the share of internal debt is covered by the thin-capitalization rule). More generally, MNCs will face a fixed cost of establishing a presence in a tax haven and will therefore not do so, if the tax gain is sufficiently small.[15] Hence, by setting a sufficiently tight CFC rule, a headquarter country could then eliminate all debt shifting to the tax haven for domestic MNCs, whereas foreign MNCs could still benefit from a permissive thin-capitalization rule. This model extension could explain the finding in Table 1.1 that some countries set CFC tax rates that are very close to their domestic statutory corporate tax rate.

1.6 Conclusion

Many governments have to cope with less tax revenue as multinational corporations are exploiting legal arbitrage opportunities in order to shift profits from high-tax to low-tax countries. Justified by this development the OECD calls for introducing and strengthening CFC rules in its member countries in its 'Action Plan on Base Erosion and Profit Shifting'. Many governments have introduced such rules and the recent empirical literature shows that multinational firms are sensitive to changes in CFC rules. Yet, the theoretical literature has so far neglected the analysis of CFC rules. This paper contributes in filling the gap.

In the paper, we identify the conditions under which binding CFC rules are part of the optimal tax mix chosen by governments. First, we show that CFC rules are part of the optimal tax mix chosen by the government if the MNC's internal debt choice responds elastically to the introduction of the CFC rule, and if it outweighs the negative effects on the domestic MNC's investment decision and on the profits of its foreign affiliates. Second, we show that a higher home bias of the domestic MNC's home affiliate induces the government to set its CFC rule tighter but its thin capitalization rule more generous. For the CFC rule, the dominant effect is that the domestic MNC's home affiliate reacts less elastic to changes in the effective capital costs which leads to a less drastic drop in the investment following a tighter CFC rule. For the thin

[15] See Krautheim and Schmidt-Eisenlohr (2011) for such a modeling approach in a setting with heterogeneous firms.

capitalization rule, the dominant effect is that a tighter CFC rule increases the tax base of the domestic MNC's home affiliate via a lower excess leverage and therefore allows the government to be more generous in its tax deductions for internal interest payments.

Our theoretical analysis offers several prediction which can be tested empirically. First, the level of the CFC rule depends - among other things - on the home bias of the domestic MNC. A higher home bias reduces the investment elasticity of the domestic MNC which results in a tighter CFC rule. Hence, countries with more profitable home markets, e.g. larger or resource-rich countries, are more likely to use a CFC rule. Second, in countries in which it is easier for MNCs to circumvent the thin capitalization rule, i.e. countries in which the MNCs' costs of concealing are rather small, strict CFC rules should go together with lenient thin capitalization rules. An analysis of these predictions is left for future research.

Chapter 2

Why do countries differ in thin capitalization rules: the role of financial development

2.1 Introduction

It is well known that multinational enterprises (MNEs) can use internal debt to shift profits from low-tax to high-tax countries.[1] In detail, affiliates in low-tax countries give loans to affiliates in high-tax countries. The interest on this loan is taxable in the low-tax country, but tax-deductible in the high tax country. This reduces overall tax payments by the amount of interest payments multiplied by the tax rate differential of the respective countries.

Many governments try to act against this behavior by implementing thin capitalization rules. Thin capitalization rules deny tax deductibility of internal loans if the size of these loans surpasses a permissible threshold. In this way, the use of internal debt for tax planning issues is limited, preventing an erosion of the tax base and hence tax revenue losses.

Over time thin capitalization rules have become an attractive policy instrument for governments. By 2005 the share of OECD countries moving to a thin capitalization rule increased from less than half to to two thirds.[2] Traditionally, the common way of

[1] Empirical evidence for such tax planning behavior is given inter alia by Huizinga et al. (2008) and Egger et al. (2010).

[2] See, e.g., table 1 in Büttner et al. (2012).

introducing a thin capitalization rule was to implement a so-called safe haven debt-to-equity ratio. The safe haven debt-to-equity ratio caps tax-deductibility of internal interest payments if affiliates exceed a defined debt-to-equity ratio. Recently, however, a number of countries including Germany, Finland, France, Portugal and Spain switched to a system of a pure earnings stripping rule. The earnings stripping rule restricts tax-deductibility if internal interest payments exceed a certain fraction of an affiliate's EBITDA.[3]

However, there is evidence that internal capital markets are also used by MNEs to allocate internal capital to affiliates that are limited in raising external funds due to a weak financial development of the host country (Desai et al., 2004; Egger et al., 2014). A strict thin capitalization rule in the sense of a low allowance to deduct internal interest payments can have serious drawbacks on local affiliates' investments. Previous studies showed that the access to finance is a major determinant of growth and development (Rajan and Zingales, 1998; Beck et al., 2000). Moreover, Manova (2013) shows that exporting firms and thus international trade are severely affect by financing restrictions. About 20%-25% of the impact of credit constraints on trade is driven by reductions in total output.

The chapter brings together these two simultaneous developments by analyzing the effects of thin capitalization rules in the presence of financial frictions. The key element of the model is a financing constraint in accordance with Tirole (2006). MNEs set up an internal capital market and allocate internal funds to those affiliates where the marginal return to capital is the highest. That means the shorter affiliates are in external funds, the higher is the marginal return to capital and hence the incentive to allocate capital to that affiliate. A more permissive thin capitalization rule decreases affiliates' capital costs and indirectly increases their opportunity to raise additional external funds.

In the model presented here, subsidiaries in a high-tax country are endowed with insufficient own resources and thus need additional funds for investment. External funds are limited by subsidiaries' pledgeable income, i.e. the income that can credibly be paid back to the external lender without distorting managerial incentives. This pledgeable income depends on subsidiaries' productivity. Highly productive subsidiaries have bigger investment opportunities and thus have a higher pledgeable income. Hence, they can raise more external funds compared to less productive affiliates. However, if

[3]For a description of thin capitalization rules for most OECD and EU countries see Gouthière (2005) and Dourado and de la Feria (2008) respectively.

the restriction on external fundraising is severe, i.e. the country's financial development is weak, highly productive affiliates are financially more constrained because the possibility to raise funds increases less than their demand.

Our first result is that, in the presence of financial frictions, governments will indeed allow some deductibility of internal interest payments to increase their tax revenues. The reason is that a permissive thin capitalization rule reduces the costs of capital for financially constrained subsidiaries and therefore fosters investment. This broadens the tax base and can overcome the negative effect of enhanced profit shifting. Moreover, the optimal thin capitalization rule gets more generous the weaker the financial development of the country. This prediction is consistent with the fact that countries with a weak financial development have a more lenient thin capitalization rule on average. Therefore, the model gives a rationale previously neglected by the literature why thin capitalization rules can differ between countries.

Our first result is that the implementation of an earnings stripping rule generates higher tax revenues than a safe haven debt-to-equity ratio. Under an earnings stripping rule, the amount of tax-deductible interest payments is based on the affiliate's EBITDA and thus on its productivity. As compared to a fixed debt-to-equity ratio, highly productive affiliates can deduct a higher amount of interest payments from their tax base than less productive affiliates. Thus, the earnings stripping rule allows the government to discriminate between different types of MNEs. This gives the government the opportunity to reduce the amount of shifted profits without changing investment levels.

Our analysis combines three strands of the literature. The first strand considers finance constraints in a taxation environment. The impossibility of effort verification is, in this context, responsible for a limited opportunity of external finance. Keuschnigg and Ribi (2013) analyse the impact of profit taxes under different tax systems when firms are financially constrained. They conclude that profit taxes have first order welfare effects even when tax rates are small. Keuschnigg and Devereux (2013) set up a model of financing frictions and offshoring of intermediate inputs. They find that the underlying arm's length price introduces a flawed benchmark and can reduce world welfare. The reason is that high transfer prices and low royalty payments of MNEs are misinterpreted as tax induced profit shifting, even though these choices are efficient for overcoming financing constraints. Egger et al. (2014) analyze theoretically several determinants of internal debt and test these empirically using data of German multinationals. Due to the incorporation of financing restrictions they find a vastly higher tax semi-elasticity of internal debt than typically found in other studies.

The second strand analyses preferential tax treatment of mobile tax bases and its effects on profit shifting. Peralta et al. (2006) show that a lenient control of profit shifting can reduce tax competition when governments cannot tax discriminate between multinational and domestic firms. In a general equilibrium model, Hong and Smart (2010) find that citizens of high-tax countries benefit if MNEs are allowed to shift some profits into a tax haven. Janeba and Smart (2003) establish consitions under which a restriction on preferential tax regimes decreases tax revenues. Mintz and Smart (2004) find support that the elasticity of taxable income with respect to tax rates is significantly higher for corporate subsidiaries that may engage in income shifting.

The third strand empirically investigates the effects of thin capitalization rules on the firms' financial structure. Weichenrieder and Windischbauer (2008), Overesch and Wamser (2010), Büttner et al. (2012), Wamser (2013) and Blouin et al. (2014) analyze the effectiveness of the safe haven rule. They all find that debt-to-equity ratios significantly declined when the thin capitalization rule was tightened. Dreßler and Scheuering (2012) and Buslei and Simmler (2012) investigate the effects of a change from a fixed debt-to-equity ratio to an earnings stripping rule in Germany in the year 2008. They find that the introduction of the new rule lowered firms' debt-to-assets ratios and their net interest payments.[4] In the theoretical literature, Haufler and Runkel (2012) is the only paper that addresses thin capitalization rules in detail.[5] They find that thin capitalization rules can be used as a policy instrument in tax competition. Smaller countries set less strict thin capitalization rules because they face the more elastic tax base. However, a crucial assumption is that firms have unlimited access to external funding. In contrast, our model allows us to study optimal thin capitalization rules in the presence of credit market frictions.

This chapter is structured as follows. Section 2.2 introduces the basic model for our analysis. Section 2.3 analyzes the optimal thin capitalization rules in a framework with credit market frictions. Section 2.4 compares the two most common thin capitalization rules, i.e. the safe haven debt-to-equity ratio and the the earnings stripping rule. Section 2.5 discusses the extension of transfer price manipulation and section 2.6 concludes.

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[4]For an overview of thin capitalization rules and a summary of the economic effects, see Ruf and Schindler (2012).

[5]Fuest and Hemmelgarn (2005) concentrate on the relationship between corporate and personal income taxation but keeping the thin capitalization rule fixed. In an extension, Hong and Smart (2010) endogenously derive the optimal thin capitalization rule of a small open economy with profit shifting MNEs.

2.2 The model

2.2.1 The basic framework

We consider a simple one-period model of two small countries, labeled 1 and 2. Let $t_1 > t_2$ so that country 1 is the high-tax country. Capital is assumed to be perfectly mobile internationally. There is a fixed number $1 + m$ of multinational enterprises (henceforth MNE) in the economy. Each MNE has one subsidiary in the tax haven country 2 and one subsidiary in the high-tax country 1. Affiliates in country 2 merely act as a lending basis. Hence, there is no production and we refer to these affiliates as the financial centers. Production takes place only in the high-tax country 1. We assume that affiliates in country 2 and in country 1 are exogenously endowed with E_2 respectively E_1 units of equity. Many economies require a minimum amount of capital that an entrepreneur needs to deposit in a bank or with a notary in order to start a business.[6] In our model, this minimum amount of capital comprises only equity and has to be raised from national investors. We assume that investors have to make their decision in which of the affiliates to invest before the productivity is drawn. As affiliates do not differ at this stage investors are indifferent in which of them to invest. As a result, each producing affiliate is initially endowed with the same amount of equity E.[7]

Let θ^j denote the productivity of affiliate j in country 1. Productivity across MNEs differs in the sense that θ^j can take on two values. Affiliates with a low productivity exhibit a value of $\underline{\theta}$ while affiliates with a high productivity have a value of $\bar{\theta}$. We normalize the number of less productive firms to unity whereas the number of firms with productivity $\bar{\theta}$ in the economy is m.

Each affiliate invests K^j units of capital to produce a homogeneous good for the world market at a world price normalized to one. Affiliates' investment is successful with probability p and unsuccessful with probability $1-p$. Success probabilities are identical for all subsidiaries, but they are uncorrelated and hence the risk of the investment is idiosyncratic. In case of success, the investment yields an end-of-period value $K^j + \theta^j f(K^j)$, where K^j is undepreciated capital and $\theta^j f(K^j)$ is the cash-flow function which exhibits the usual properties of positive but decreasing returns, i.e. $f'(K^j) > 0 > f''(K^j)$. If the investment fails the end-of-period value of the subsidiary is zero. We assume that investment opportunities exceed own funds ($K^j > E$). Hence, a

[6] See http://www.doingbusiness.org/

[7] For convenience, we drop the subscript of equity endowment in country 1.

financing gap arises that has to be filled by internal debt I^j or external funds D^j.[8] Investment is therefore financed by $K^j = E + I^j + D^j$. In case of a failing investment neither external nor internal debt is repaid.

External funds have to be raised from national credit markets. For simplicity, we assume that external funds consist of passive bank credits meaning that banks do not engage in any monitoring activities. External lenders can choose to give a credit to an affiliate or to earn a safe return R on the deposit market. They are willing to give a credit if the expected repayment of external funds is at least as high as the end-of-period value of the safe investment. With $r \equiv 1 + R$ as the end-of-period value of the safe investment, the external lender is willing to give a credit if $p(1 + i) \geq r$. Competition among external lenders results in zero profits so that the constraint holds with equality.

Additionally, MNEs can operate an internal capital market and shift capital to their producing affiliate. Similar to the external lenders, lending operations of the MNEs are only profitable if the expected repayment satisfies $p(1 + i) \geq r$. We assume that MNEs cannot charge a higher premium on loans than the external lenders. This implies that MNEs cannot use interest pricing as a means of profit shifting.[9] In contrast to external funds, internal loans can be used to minimize the global tax bill of the MNE by shifting profits from the high-tax country to the low tax country. In fact, a loan from an affiliate in a low-tax country to an affiliate in a high-tax country increases tax payments in the low-tax country amid to a higher interest income. However, the tax base in the high-tax country decreases by more if interest payments are deductible.

In general, countries can reduce this incentive by implementing controlled-foreign-corporation rules along with thin-capitalization rules. These rules limit the use of preferential tax regimes by overriding the tax-exemption principle and taxing passive income (e.g. interest payments) according to the tax credit method, if some conditions are met.[10] However, MNEs can circumvent these rules, e.g. by taking measures that reclassify the income in the tax haven as active income. We model this argument in a highly stylized way by specifying a convex cost function $C(I^j)$. We assume that affiliates in country 1 have to bear these administrative costs.

In our model, affiliates have to pay taxes in the source country. Each subsidiary has to

[8]New equity as a source of finance is ruled out. Empirically, new equity as a form of financing investments is small, see Bond (2000).

[9]In section 2.5, we discuss the possibility of transfer price manipulation.

[10]See Haufler et al. (2014) for a theoretical analysis of controlled-foreign-corporation rules.

pay taxes proportional to its cash-flow. In principle, both external and internal interest payments are tax-deductible. However, deductibility of internal interest payments is limited by a thin capitalization rule which we denote by z. This thin capitalization rule permits the deductibility of internal interest payments up to a threshold $\phi^j(z)$ which can be firm-specific. Any further interest payments of internal debt are not deductible from the tax base. Expected tax payments of producing affiliates in country 1 are therefore given by

$$E(T^j) = pt_1[\theta^j f(K^j) - iD^j - i\ min(I^j, \phi^j(z))]. \tag{2.1}$$

In the case of a successful investment, total plant value of the affiliate V_1^j is split among the affiliate's stakeholders, $V_1^j = V_{1,A}^j + V_{1,I}^j + V_{1,D}^j$, with $V_{1,A}^j$ as end-of-period value of affiliate 1's dividends, $V_{1,I}^j$ as end-of-period value of affiliate 1's internal debt and $V_{1,D}^j$ as end-of-period value of affiliate 1's external debt. Each MNE's central management maximizes its net present value V^j composed of the value of the subsidiary in the high-tax country V_1^j and the value of the subsidiary in the tax haven V_2^j.[11] The central management's maximization problem can be written as

$$\begin{aligned} \max_{I^j} \quad & V^j = V_1^j + V_2^j \\ \text{s.t.} \quad & I_1^j + I_2^j = 0. \end{aligned} \tag{2.2}$$

Within the MNE, it must be the case that lending and borrowing add up to zero. We assume that the tax-exemption principle is generally applicable in our model. Therefore, repatriated profits are tax-exempt in the home country of the central management.[12]

The timing of the central management's decisions is as follows: Firstly, internal loans are allocated. Secondly, external debt is raised and investment takes place. Thirdly, managerial effort is induced. And lastly, external debt is repaid and dividends are paid to the central management. We solve the model by backward induction starting from stage three.

[11]The financial center is not producing any goods, so the net present value of this affiliate is solely determined by the value of internal debt.

[12]In the European Union, for example, this is ensured by the Parent-Subsidiary Directive. For a recent discussion and analysis see Becker and Fuest (2010).

2.2.2 Managerial effort and external financing constraints

We assume that the central management chooses the effort level in the affiliate in country 1. If the central management chooses to exert a high effort level, the affiliate's probability of success is also high. Instead, it can deploy a low level of effort thereby reducing the probability of success to $p_L < p$. Doing so, the central management can consume a private benefit bK^j proportional to the investment. Accordingly, the higher the private benefit bK^j the central management can consume, the lower is the incentive to execute a high effort level.

Since the central management maximizes the total net value of the MNE, it obtains the expected surplus of the producing affiliate consisting of repatriated dividends V_A^j and the repayment of internal debt V_I^j. If the investment is successful, the investment's end-of-period pre-tax value is $K^j + \theta^j f(K^j)$. In that case, the external credit has to be paid back and taxes T^j have to be remitted. Moreover, the central management takes into consideration that the opportunity cost for internal debt accrue even if the subsidiary is unsuccessful. Likewise, opportunity costs for equity and administrative costs of internal debt accrue in any case. The expected surplus of the subsidiary is then given by

$$\upsilon^j = p[K^j + \theta^j f(K^j) - (1+i)D^j - T^j] - r(E + I^j) - C(I^j). \tag{2.3}$$

The central management will exert high effort only if $\upsilon^j(p) \geq \upsilon^j(p_L) + bK^j$. Substituting (2.3) yields

$$p[K^j + \theta^j f(K^j) - (1+i)D^j - T^j] \geq \beta K^j, \quad \beta \equiv \frac{p}{p - p_L} b. \tag{2.4}$$

Equation (2.4) determines the maximum amount of external debt D^j the subsidiary can raise. The reason why the use of external credits is constrained is the following. The total net surplus of the subsidiary has to be split among the central management and the external lender. The higher the share of capital from the external lender, the higher is also the share of the surplus the external lender gets. However, the central management's compensation must at least be βK^j. If not, it reduces the effort level and the external lender would not break even. The amount of external debt the affiliate can raise therefore crucially depends on the income which can credibly be paid back to the external lender, i.e. the pledgeable income.

Furthermore, the amount of external funds that can be raised depends on β. The higher is β the lower is the amount of external funds subsidiaries can raise. In our model, β can be interpreted as the financial development of the country. A high value of β corresponds to a financially less developed country, where access to the national capital market is severely constrained. One reason could be that the quality of intermediaries, i.e. their monitoring effort, is low and hence the incentive to give a credit.

2.2.3 The investment decision and the allocation of internal funds

To determine the subsidiaries' investment levels, we insert subsidiaries' tax payments in equation (2.1) into (2.4) and substitute external debt $D^j = K^j - I^j - E$. This determines affiliates' constraint for optimal investment (COI)

$$V_1^j \equiv p[(1-t_1)(\theta^j f(K^j) - iK^j) - t_1 iE] \geq \beta K^j - r(I^j + E) + pt_1 i\omega^j, \qquad (2.5)$$

where $\omega^j = [I^j - min(I^j, \phi^j(z))]$. As explained in the previous section, subsidiaries are limited in raising external funds as the incentive to exert effort is distorted if the external credit is too high. More external debt raises the end-of-period value of the affiliate, i.e. the left-hand side of the COI, in a concave manner. However, the private benefit the central management can consume, and therefore the right-hand side of the COI, increases linearly with the amount of external debt employed. At a certain level of lending the affiliate has exhausted its external debt capacity and the COI becomes binding. At this point, a further increase in external funds would raise the right-hand side of the COI at a faster rate than the left-hand side. Furthermore, as we focus on credit market frictions, we assume that for some subsidiaries the limitation of external funds confines their level of investment. This means that these affiliates would like to invest more because the marginal return on investment is higher than the marginal cost, but are constrained by inability to raise further external funds. We define μ^j as the net of tax excess return of investment

$$\mu^j \equiv p(1-t_1)[\theta^j f'(K^j) - i] \geq 0. \qquad (2.6)$$

However, the government can alleviate the financing constraint by implementing a thin capitalization rule that allows to deduct a higher amount of internal interest payments from the tax base. With a more generous thin capitalization rule MNEs have an incentive to allocate more internal loans to their producing subsidiary. This, in turn, increases the surplus of financially constrained affiliates as they can reach a higher investment level and raise further external funds without distorting the central management's incentives. This means that the right-hand side of the COI increases only by $\beta - r$ which we assume to be smaller than μ^j.[13] This ensures that the external lender in indeed willing to give an additional credit if own resources of the affiliate increase.

This leaves us with the question, whether the more or the less productive subsidiaries are hit harder by the financial constraint. There are two countervailing effects of an increase in productivity. First, a higher productivity increases the marginal excess return of capital μ^j and hence makes highly productive subsidiaries more constrained, other things being equal, i.e. subsidiaries need more capital to reach the first-best investment level. Second, the higher is the productivity of the affiliate, the bigger is the central management's incentive to allocate internal loans to its subsidiary leading to an increase in the subsidiarie's pledgeable income. This enables high-productivity subsidiaries to raise more external funds. Which of the two effects depends on the financial development β. If the financial development is sufficiently weak high-productivity subsidiaries are the ones with the larger excess return μ^j. This is because the additional capital demand of high-productivity subsidiaries is not satisfied by the higher internal loan and the additional external funds.[14]

In the following, we assume that β is sufficiently high. As less productive affiliates have the lower excess return on investment, we normalize for simplicity their excess return to zero ($\underline{\mu} = 0$).[15] Thus, only highly productive affiliates have an excess return on investment ($\bar{\mu} > 0$). Less productive subsidiaries are financially unconstrained meaning that they can raise enough external capital, so that their investment is first-best.[16] These affiliates use internal loans only for the reason to minimize their tax payments. In contrast, highly productive subsidiaries use internal debt also to increase their investment levels.

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[13]As the marginal unit of internal interest payments is tax-deductible, the value of ω^j becomes zero for this unit.

[14]In Appendix B, we derive an explicit threshold for β which ensures that highly productive subsidiaries are financially more constrained.

[15]We denote values for the less (more) productive subsidiaries with a lower (upper) bar.

[16]Relaxing this assumption does not change the qualitative results of our analysis. The difference would be that starting from the point where no tax deduction for internal interest payments is permitted the government benefits also from less productive subsidiaries. However, at a certain point less productive subsidiaries will no longer increase their investment whereas highly productive subsidiaries still do since these are financially more constrained.

The central management chooses that amount of internal loans which maximizes the end-of-period value of the MNE. The end-of-period value is the sum of the end-of-period value of the producing subsidiary and the end-of-period value of the financial center. Total end-of-period value of the MNE is given by

$$\begin{aligned} V^j &= p\left[(1-t_1)\theta^j f(K^j) - (1-t_1)iD^j - iE - iI^j + t_1 i\; min(I^j, \phi^j(z))\right] \\ &+ (1-t_2)\pi_1 - pt_2 iI^j - rE_2 - C(I^j), \end{aligned} \tag{2.7}$$

with π_1 as the end-of-period book surplus of the financial center. The maximization process of financially unconstrained affiliates can be seen as a two stage process. In a first step, internal loans are allocated to optimize the financial structure. In a second step, the affiliate chooses the optimal amount of external funds for the output decision. The optimal amount of external debt is given by differentiating (2.7) with respect to D^j

$$p(1-t_1)[\underline{\theta} f'(\underline{K}) - i] = 0. \tag{2.8}$$

In order to minimize the overall tax payments, producing affiliates replace equity E by internal loans $\underline{I}$ from the financial center as long as internal interest payments are tax-deductible and agency cost are not too high. This ensures tax deductibility and therefore increases after-tax profits of the MNE. Unused equity is placed at the deposit market where the affiliate obtains a payment of r which is as high as the opportunity cost.

Highly productive subsidiaries cannot raise sufficient external funds. Hence, in contrast to less productive affiliates, the marginal investment is determined by internal loans. Differentiating (2.7) with respect to I^j implicitly defines the optimal amount of internal loans

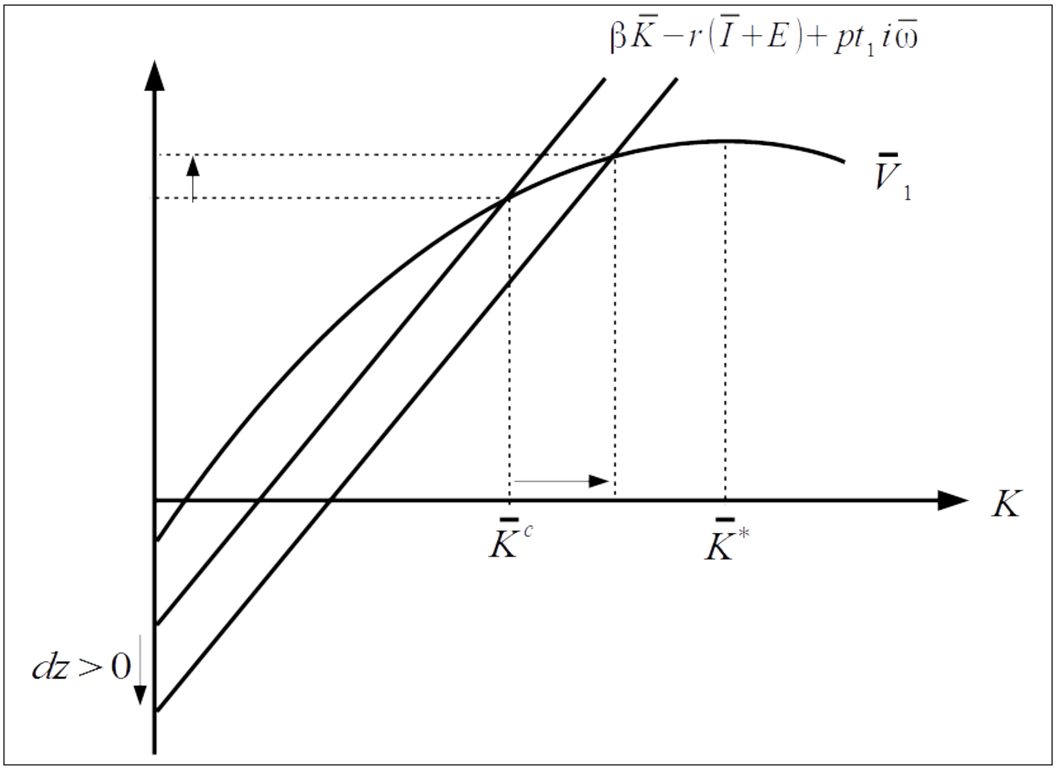
$$C'(\bar{I}) = p[(1-t_1)\bar{\theta} f'(\bar{K}) - i + (\lambda t_1 - t_2)i], \tag{2.9}$$

where λ is a dummy variable that takes the value of unity if the marginal unit of internal interest payment is tax-deductible and zero otherwise. Highly prductive affiliates differ in the way that apart from tax planning, internal loans also serve these affiliates to increase their investment.

Figure 2.1 depicts subsidiaries' investment levels depending on the productivity level θ^j, the thin capitalization rule z and the financial development β.[17] In the figure, the

[17]For clarity, we concentrate in the graph on highly productive affiliates.

Figure 2.1: Investment level and internal loan allocation



curved line patterns highly-productive subsidiaries' end-of-period value $\bar{V}_1$, i.e. the left-hand side of the COI. Likewise, the straight line pictures the right-hand side the COI. Highly productive affiliates are financially constrained so that their maximal investment level $\bar{K}^c$ is lower than the first-best level $\bar{K}^*$. At this point, these affiliates do not get any further external funds as this would distort managerial incentives. A more generous thin capitalization rule induces MNEs to give a higher credit to their subsidiary. This raises high-productivity subsidiaries' pledgeable income and allows them to raise additional external funds. This is depicted by a downward shift of the straight line. As a result investment increases. In contrast, a more generous thin capitalization rule does not affect less productive affiliates' investment as external funds suffice for first-best investment.

2.3 Optimal thin capitalization rule

The incentives of the two types of affiliates highlight the trade-off for the government with respect to the implementation of a thin capitalization rule. A more generous thin capitalization rule allows higher interest deductions of internal debt. This induces all MNEs to shift more internal debt to their subsidiary in country 1. Financially constrained subsidiaries use these additional funds to increase their investment levels. In contrast, financially unconstrained subsidiaries do not increase their investment in reaction to a more generous thin capitalization rule. These subsidiaries will only use the tax shield to shift profits into the low-tax country.

We postulate that the government maximizes its corporate tax revenues.[18] From a theoretical perspective, the assumption that the profit income of MNEs does not enter the government's objective function corresponds to a setting where the residents of each country invest their capital in perfectly diversified global portfolios.[19] Furthermore, we assume for simplicity that national tax rates are exogenous.[20] Thus, tax revenues are maximal if the tax base is largest. Country 1's expected tax revenues are given by

$$E(T_1) = pt_1\{\underline{\theta} f(\underline{K}) - i\underline{D} - i\underline{\phi}(z) + m[\bar{\theta} f(\bar{K}) - i\bar{D} - i\bar{\phi}(z)]\}. \tag{2.10}$$

In the case of unsuccessful investments end-of-period values of the subsidiaries and also tax-deductions are zero. Only if investments are successful is country 1's tax base positive. Then, country 1's tax base consists of the cash-flow of all subsidiaries resident in country 1. This tax base is reduced by the tax shield of external debt and the cost of tax grants for internal debt. The latter can be different between highly productive subsidiaries, $\bar{\phi}(z)$, and less productive subsidiaries, $\underline{\phi}(z)$.[21] Both sources of costs depend on the kind of thin capitalization rule z the government implements.

Taking the tax rate as given and maximizing tax revenues with respect to z implicitly

[18]Our results would not change qualitatively under a welfare maximizing government, where welfare is composed of weighted corporate tax revenues and income of the local affiliates (consumer surplus is unchanged as the output price is fixed). The lower is the weight on tax revenues the less important are the costs of the thin capitalization rule and the more important is the income of local affiliates. If tax revenues are not considered, welfare is maximized if affiliates' investment is first-best. In the optimum, the government would fully allow the deductibility of internal interest payments. Hence, the lower is the weight on tax revenues, the more generous is the thin capitalization rule.

[19]Empirically, globally diversified portfolios are a plausible scenario when most of the small country's capital is invested through financial intermediaries, such as pension funds or insurance companies.

[20]The effects of a profit tax on financially constrained firms is analysed by Keuschnigg and Ribi (2013). They show that profit taxes of even a small magnitude are investment and welfare decreasing. For this reason, we abstract from statutory tax issues and squarely focus on the thin capitalization rule. Despite that, endogenizing the choice of the tax rate increases the complexity of the analysis without adding additional insights.

[21]In the model, we assume that administrative costs of internal loans are not too convex such that affiliates will always make use of a higher allowance of interest deductibility. Thus, the costs for the government are equivalent to the affiliates' thresholds $\bar{\phi}(z)$ and $\underline{\phi}(z)$.

determines the optimal thin capitalization rule[22]

$$m\left(\frac{\partial[\bar{\theta}f(\bar{K})]}{\partial z}-i\,\frac{\partial\bar{\phi}(z)}{\partial z}\right)=i\frac{\partial\underline{\phi}(z)}{\partial z}. \tag{2.11}$$

Relaxing the thin capitalization rule has two effects on government 1's expected tax revenues. Firstly, every subsidiary will use more internal debt to reduce its costs of capital. This induces costs for the government arising from tax planning of less productive subsidiaries (right hand side of (2.11)) which reduces country 1's tax base. Secondly, internal loans used by the m financially constrained subsidiaries increases their investments and hence the tax base. Thus, the government weighs the tax gain from the additional investments of highly productive affiliates against the tax losses from merely profit shifting low-productivity subsidiaries.[23]

In the case of a financially advanced country 1, highly productive subsidiaries could raise sufficient external funds. This would mean that independent of the level of productivity, each subsidiary's investment would be first-best. A more generous thin capitalization rule would just induce the MNEs to shift profits into the low-tax country without enhancing investment in the high-tax country 1. In equation (2.11), $\frac{\partial[\bar{\theta}f(\bar{K})]}{\partial z}=0$, i.e. the investment of high-productivity affiliates is not changing. In this case, the government would fully disallow tax-deductibility of interest payments for internal loans. Therefore, we can summarize our findings in

Proposition 2.1 *In a setting where firms are financially constrained, the optimal thin capitalization rule allows positive internal interest deductions.*

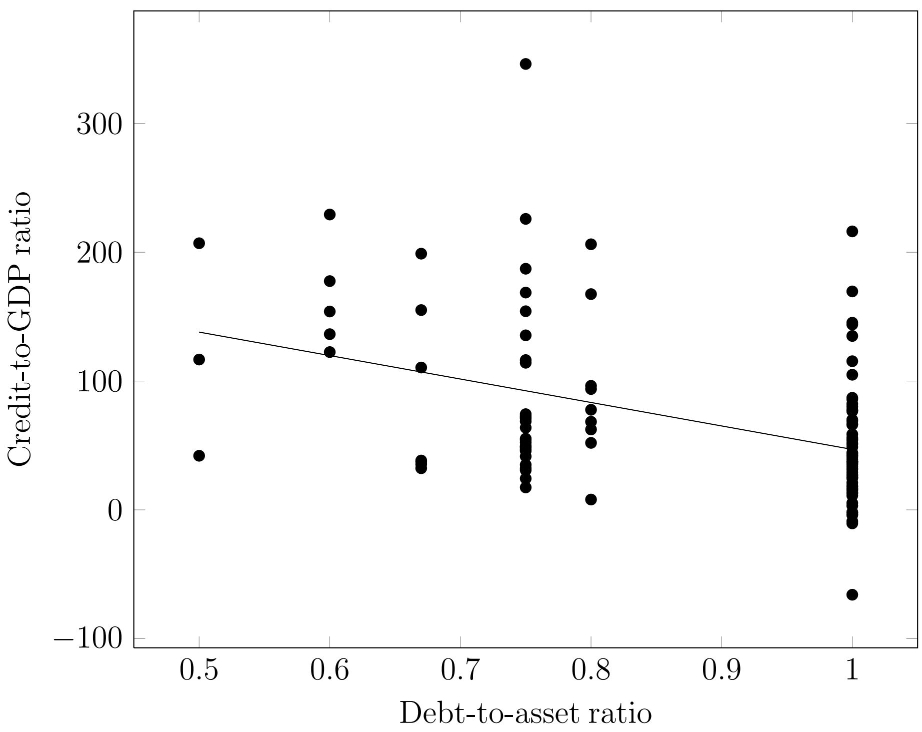
Proposition 2.1 highlights a simple, yet previously neglected, motive why governments set lenient thin capitalization rules. In the presence of financial frictions governments are willing to set a more generous thin capitalization rule in order to reduce the costs for loans thereby enhancing investments of some subsidiaries. The incentive to be generous in the thin capitalization rule gets stronger, the higher the excess return on investment of the highly productive affiliates (cf. (2.11)). Thus, the incentive is stronger, the weaker the financial development of the country, i.e. the higher β.

[22] Changes in the amount of external finance for the highly productive affiliates due to a change in the thin capitalization rule are incorporated in the marginal return on investment $f'(\bar{K})$. Less productive affiliates do not change the level of external funds at all as their investment is already first-best.

[23] It could be the case that the government has no incentive to allow any deduction for internal interest payments although highly productive subsidiaries increases their investment. This is true if the marginal return of investment is lower than the costs of a more generous rule $-t_1 i$. Thus, the tax revenue from highly productive subsidiaries would also be negative.

We provide some suggestive evidence for this predition by plotting countries' financial development against their thin capitalization rule. Following the literature (Arezki and Brückner, 2012; Chinn, Eichengreen and Ito, 2014; von Hagen and Zhang, 2014), the level of financial development is measured by domestic credit provided by the banking sector as a percentage of GDP (henceforth credit-to-GDP ratio). For the credit-to-GDP ratio, we use data provided by the World Bank for the year 2012 if available. Otherwise, we use the latest data available. For countries' thin capitalization rules, we collect data on debt-to-equity ratios from the European Tax Handbook (2013) and the Global Corporate Tax Handbook (2013) and convert them to debt-to-asset ratios.[24] Figure 2.2 shows a negative correlation implying that countries with a weak financial development have a more generous thin capitalization rule, on average. This observation is consistent with the prediction of our model.

Figure 2.2: Relation of thin capitalization rule and financial development



[24]Using the debt-to-asset ratio introduces an upper limit of unity for those countries that have no thin capitalization rule at all. Note also that for those countries which have recently switched to an earnings stripping rule, Figure 2.2 uses the former debt-to-asset ratio.

2.4 Safe haven rule vs. Earnings stripping rule

Our analysis in the previous section has shown that the implementation of a lenient thin capitalization rule can result from limited access to external funding. In this section, we compare two systems, the safe haven debt-to-equity ratio and the earnings stripping rule and ask which one is preferable. The debt-to-equity ratio disallows the tax deduction of interest payments to related parties if internal debt exceeds the country-specific debt-to-equity ratio. The permissible amount of internal debt is calculated from the amount of equity within the subsidiary, multiplied by the debt-to-equity ratio. The earnings stripping rule disallows the tax deduction of interest payments to related parties if internal debt exceeds a certain proportion of the affiliate's earnings before interest, taxes, depreciation and amortization (EBITDA). This rule, therefore, is based on the affiliate's economic activity.

We begin our analysis by first considering the effects of a safe haven rule on the allocation of internal loans. The end-of-period value of MNEs is given by

$$\begin{aligned} V^j =& p[(1-t_1)(\theta^j f(K^j) - iK^j) - t_1 i(I^j + E) + t_1 i \, min(I^j, \delta)] \\ & - C(I^j) + (1-t_2)\pi(\theta^j) - pt_2 iI^j - rE, \end{aligned} \tag{2.12}$$

where $\phi^j(z) = \delta$ is the threshold for the tax-deductibility of internal interest payments under the safe haven rule. Given the level of equity, the safe haven rule δ allows the subsidiary to tax-deduct internal interest payments on a one-to-one basis.

For the earnings stripping rule, the end-of-period value of MNEs is instead given by

$$\begin{aligned} V^j =& p[(1-t_1)(\theta^j f(K^j) - iK^j) - t_1 i(I^j + E) + t_1 i \, min(I^j, \alpha\theta^j f(K^j))] \\ & - C(I^j) + (1-t_2)\pi(\theta^j) - pt_2 iI^j - rE, \end{aligned} \tag{2.13}$$

where $\phi^j(z) = \alpha\theta^j f(K^j)$ depicts the threshold of tax-deductibility of internal interest payments under the earnings stripping rule. Under this rule the threshold of tax-deductibility differs across subsidiaries. A more generous earnings stripping rule increases subsidiaries' allowance for tax-deduction by a factor $\theta^j f(K^j)$. Highly productive subsidiaries can deduct a higher amount of internal interest payments as compared to less productive ones because they have a higher EBITDA.

In the following we consider which of the two thin capitalization rules generates the higher expected tax revenue for the government. Since we take the tax rates as exogenously given, higher expected tax revenues go along with a higher expected tax base. Expected tax bases differ depending on the thin capitalization rule. Under the safe haven rule country 1's expected tax base is given by

$$pB(\delta) = p[\underline{\theta} f(\underline{K}(\underline{\theta}, \delta)) + m\bar{\theta} f(\bar{K}(\bar{\theta}, \delta)) - (1+m)r\delta], \tag{2.14}$$

consisting of the cash-flows of less productive and highly productive affiliates less total tax deductions of internal interest payments under the safe haven rule. As the safe haven rule is country-specific, the cost of the safe haven rule is proportional to the number of affiliates in the country.

Under the earnings stripping rule country 1's expected tax base is instead given by

$$pB(\alpha) = p\{\underline{\theta} f(\underline{K}(\underline{\theta}, \alpha)) + m\bar{\theta} f(\bar{K}(\bar{\theta}, \alpha)) - \alpha r[\underline{\theta} f(\underline{K}(\underline{\theta}, \alpha)) + m\bar{\theta} f(\bar{K}(\bar{\theta}, \alpha))]\}, \tag{2.15}$$

with the difference that the cost of the earnings stripping rule is firm-specific and depending on the productivity. Highly productive subsidiaries have a higher threshold and therefore generate higher costs for the government. The difference in tax bases between the two rules is given by

$$\begin{aligned}\frac{\Delta}{p} = B(\alpha) - B(\delta) = m\bar{\theta}[f(\bar{K}(\bar{\theta}, \alpha)) - f(\bar{K}(\bar{\theta}, \delta))] - mr[\alpha\bar{\theta} f(\bar{K}(\bar{\theta}, \alpha) - \delta] \\ + \underline{\theta}[f(\underline{K}(\underline{\theta}, \alpha)) - f(\underline{K}(\underline{\theta}, \delta))] + r[\delta - \alpha\underline{\theta} f(\underline{K}(\underline{\theta}, \alpha))].\end{aligned} \tag{2.16}$$

To compare these two thin capitalization rules, we assume a government with a tax revenue maximizing safe haven debt-to-equity ratio $\delta = \delta^*$. We then ask whether there exists an earnings stripping rule that generates higher expected tax revenues than the optimal safe haven debt-to-equity ratio. To answer this question, suppose an earnings stripping rule α^δ such that the highly productive subsidiaries get the same tax deduction, i.e.

$$\alpha^\delta \bar{\theta} f(\bar{K}(\bar{\theta}, \alpha^\delta)) = \delta^*. \tag{2.17}$$

First, highly productive subsidiaries have the same tax deduction under both systems. Accordingly, their investment level is also the same under both systems (first term on the right-hand side of (2.16)). Second, the incurred costs for the government by both thin capitalization rules are the same by definition (second term). Third, the investment level of less productive subsidiaries does not change as the first-best level can be reached with only external funds (third term). Hence, tax bases do not differ with respect to these three effects. However, due to the lower EBITDA, less productive subsidiaries cannot claim the same amount of tax rebates under the earnings stripping rule as compared to the safe haven rule ($\alpha^{\delta}\underline{\theta}f(\underline{K}(\underline{\theta},\alpha^{\delta})) < \delta^{*}$). Therefore, the government incurs fewer costs from less productive subsidiaries leading to a higher tax base under the earnings stripping rule than under the safe haven rule. This is given by

$$\frac{\Delta}{p} = \alpha^{\delta} r[\bar{\theta} f(\bar{K}(\bar{\theta},\alpha^{\delta})) - \underline{\theta} f(\underline{K}(\underline{\theta},\alpha^{\delta}))] > 0. \tag{2.18}$$

We can summarize our findings in

Proposition 2.2 *In a setting where firms are financially constrained, tax revenues are higher under an earnings stripping rule for given investment decisions of both firm types, as compared to a safe haven rule.*

Looking at countries' thin capitalization rules, we see that the bulk of them has implemented a safe haven debt-to-equity ratio.[25] One reason why none of the financially less developed countries has introduce an earnings stripping rule could be that the safe haven rule is associated with relatively low administrative costs because the threshold of internal interest payments is country-specific and internal debt-to-equity ratios are relatively easy to check. Under an earnings stripping rule thresholds are firm-specific so that the administrative costs tend to be higher. However, we show that exactly for financially less developed countries it could be worth switching to an earnings stripping rule.

2.5 Extension: Allowing for profit shifting

In our model, MNEs are able to shift profits into the low-tax country 2. They do so by deciding upon the quantity of internal loans, while sticking to the arm's length price. However, it could also be true that MNEs manipulate transfer prices. MNEs could then have an incentive to provide the subsidiary with more internal loans but also with a more expensive credit by demanding a higher interest rate $i^{P} > i$.[26] In this way, MNEs have a second channel to engage in profit-shifting by manipulating transfer

[25] Only five countries switched to a pure earnings stripping rule. These countries are Finland, Germany, Italy, Portugal and Spain. These countries are also financially advanced.

[26] We drop firm superscripts in this section.

prices. However, in contrast to debt shifting transfer prices are only used for tax-saving purposes and not for allocative reasons. Administrative costs related to internal loans now also depend on the transfer price i^P, so that $C = C(i^P, I)$. Under this more complex cost function the optimal thin capitalization rule can also be influenced by the possibility of transfer price manipulation.

If the costs of debt-shifting and of transfer price manipulation are separable, the optimal thin capitalization rule is unaffected by the possibility of transfer prices. The government has an incentive to be as strict as possible in the regulation of transfer prices for two reasons. If the government is loose in the regulation of transfer prices, a higher i^P firstly increases the amount of profits shifted by the financially unconstrained subsidiaries. Secondly, it increases capital costs for financially constrained subsidiaries, thereby reducing their investment. Both effects reduce tax revenues.

However, as Schindler and Schjelderup (2013) pointed out, matters are not that clear if the costs of debt shifting and transfer price manipulation are interdependent. These costs can either interact in a substitutive or in a complementary way. Substitutability is defined by the authors as a marginal decrease in the cost of debt-shifting when transfer prices decrease (and vice versa). Likewise, complementarity means that marginal costs of debt shifting increase if transfer prices decrease. As in the case without interdependency in the costs, a stricter regulation of transfer prices reduces the amount of profits shifted. Under cost complementarity, the central managements now allocates fewer loans to their subsidiary which worsens the financial situation of all highly productive affiliates. As a result, stricter regulations of transfer prices reduce the amount of debt-shifting but also the overall investment level. However, the government could increase expected tax revenues by being more generous in its thin capitalization rule. At this point, it must be that

$$m\left(\frac{\partial[\bar{\theta}f(\bar{K})]}{\partial z} - i\,\frac{\partial\bar{\phi}(z)}{\partial z}\right) > i\frac{\partial\underline{\phi}(z)}{\partial z}. \tag{2.19}$$

This inequality is reversed under cost substitutability. Stricter transfer price regulations reduce the marginal costs for debt shifting. Central managements allocate more loans to their subsidiary, relaxing the financing constraint. The benefits of a lenient thin capitalization rule are smaller so that under cost substitutability the thin capitalization rule is comparably less generous. Thus, the qualitative result of Proposition 2.1 still holds under the extended cost function.

As the difference in thin capitalization rules under the new cost function is just of quantitative manner, we can make use of the same argument as we did in section 2.4 when examining the comparison of the two types of thin capitalization rules. Irrespective of how costs interact, an earnings stripping rule can generate higher tax revenues for the government because it allows the government to discriminate in favor of highly productive subsidiaries by granting them the same amount of tax deduction as under a safe haven rule. Thus, Proposition 2.2 also holds under the more complex cost function.

2.6 Conclusions

This chapter has introduced a model where a high-tax country chooses its optimal thin capitalization rule in the presence of financial frictions. The key element of the model is a financing constraint that restricts MNEs' ability to raise external funds. The restriction depends on subsidiaries' pledgeable income. Since subsidiaries differ in their productivity, the highly productive ones can raise more external funds in absolute terms. However, if the restriction is severe, highly productive subsidiaries are relatively more constrained because available funds increases less than their demand.

In the absence of such financial frictions, the government has no incentive to grant any deductibility of internal interest payments because MNEs would only use this allowance to shift profits out of the high-tax country. However, if the financial development of the country is weak at least highly productive subsidiaries need internal loans for real economic reasons. In this case, the government sets a thin capitalisation rule that allows positive interest deductions. This assists highly productive affiliates to at least partly overcome the financing friction which, in turn, increases the country's tax base. A more generous thin capitalization rule in this setting turns out to be a Pareto improvement. We show that this prediction is consistent with countries' tax policy. By comparing countries' thin capitalization rules and their financial development, we see indeed a negative correlation suggesting that financially less developed countries have a more generous thin capitalization rule on average. Therefore, the model offers an explanation for why countries differ in their thin capitalization rule apart from beggar-thy-neighbor policies on which the previous literature has focused.

A second result is that the implementation of an earnings stripping rule, where the amount of tax-deductible interest payments is based on the affiliate's EBITDA, is better suited to raise tax revenues as compared to a fixed debt-to-equity ratio. The reason is that the earnings stripping rule allows the government to discriminate in favor of highly productive subsidiaries. Thus, a switch to an earnings stripping rule can reduce the amount of profits shifted by the less productive affiliates without changing the overall investment level of the country.

Our model can be extended in several ways. First, our model captures only the so-called bright side of the internal capital market. This is because managers can only influence the probability with which the cash-flow is positive and not the size of the cash-flow itself. In a framework where managers can also influence the size of the cash-flow, managers' cash-flow depends not only on their own effort but also on the effort of managers in other affiliates. Managers' incentive to exert effort is therefore distorted by the incentive of MNEs to shift resources to other affiliates (see Köthenbürger and Stimmelmayr, 2013). Adding this realistic features reduces the incentive to give an internal loan to the high-tax affiliate as this increases the cost for the MNE to shift capital by inducing managers of other affiliates to exert a lower level of effort. This makes high-productivity affiliates in the high-tax country even more financially constrained. Hence, the government has an incentive to increase the amount of tax deductions for internal interest payments. Second, the model could be incorporated in a tax competition framework in which countries can also decide on their tax rate. Different types of thin capitalization rules may have diverse effects in the competition for mobile firms. As the earnings stripping rule discriminates between different types of firms also the tax rate sensitivity of firms could be affected differently. It is therefore a priori not clear how the degree of tax competition is affected if countries can choose the type of the thin capitalization rule. We leave this issue for future research.

Chapter 3

Tax avoidance strategies in (probably) loss-making affiliates

3.1 Introduction

In recent years, tax avoidance and earnings management in affiliates of multinational companies are hotly debated issues. Popular newspapers and government commissions (e.g., Bergin, 2012; Levin and McCain, 2013) picked up the cases of big global player such as Apple, Google and Starbucks that hardly pay any taxes anymore. In its "Base erosion and profit shifting" (BEPS) report, the OECD (2013) confirms that the losses in tax revenue are substantial and identifies transfer pricing and debt shifting (i.e., thin-capitalization, particularly by using internal debt from related companies) as the two main strategies for shifting profits from high-tax to low-tax countries. Both devices to reduce multinationals' overall tax payments are well-analyzed and well-understood in the accounting, the finance, as well as the economics literature.[1]

It is also well-known and intuitively straightforward that the incentive to shift profits out of high-tax countries is reversed if the affiliates in such countries are running losses. In loss-making affiliates, the effective tax rate drops to zero, and because intertemporal loss offsets are limited and cannot be carried forward with interest,

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This chapter is based on joint work with Arnt O. Hopland and Dirk Schindler.

[1] Gresik (2001) and Göx and Schiller (2007) survey relevant transfer-pricing literature; Mintz and Weichenrieder (2010) provide an overview on (internal) debt shifting, while Huizinga et al. (2008) and Møen et al. (2011) introduce external debt shifting into the picture. The accounting literature on empirical tax research is reviewed by Shackelford and Shevlin (2001) and Hanlon and Heitzman (2010).

multinationals have a clear incentive to balance losses immediately by shifting in income from other affiliates. Hence, there is some bunching around zero profits for affiliates of multinationals (compared to domestic firms), see Grubert et al. (1993, chapter 7.4). Maybe due to the fact that this intuition appears to be very simple at first glance, the literature on profit shifting in loss-making affiliates has been very small and limited to date. However, all available literature has totally neglected that reverting the tax-avoidance mechanisms within a tax year, in order to shift in profits instead of shifting profits to low-taxed profit centers, requires a lot of flexibility. In principle, this flexibility can be limited, because reverting profit-shifting channels can interfere with internal incentive systems for local management; arise suspicion at tax authorities; and be bounded by other transaction costs.[2]

This chapter points out in its theory part that (in-)flexibility in reverting the profit-shifting streams has crucial implications for firm's behavior in achieving a tax-efficient earnings management also under losses. Only under perfect flexibility, any profit shifting can be adjusted ex post ("at year's end") to ensure zero taxable profits. If there is hardly any flexibility, all firms are forced to take the likelihood of running losses at year's end into account and need to adjust their tax-management strategies ex ante – no matter whether they will run operating profits or losses in the end. Our empirical approach provides evidence for the assumption that transfer pricing gives substantial flexibility to firms so that they can adjust their profit shifting ex post. On the contrary, we do not find any evidence for flexibility in the capital structure. Accordingly, we can suggest that most debt-shifting decisions must be taken at the beginning of the tax year (or even earlier). One important implication from our finding on debt shifting is then that it is the expected tax-rate differential that should be taken into account when estimating the effect of tax shields on multinationals' capital structures. By neglected this issue, the debt-shifting literature underestimates both the impact taxes have on firm's (internal) debt-to-asset ratios and the magnitude of debt shifting.

In order to analyze these issues, we set up a simple model of a multinational company that owns productive affiliates in n countries and hosts a profit and financial center in a tax haven. The tax-haven affiliate uses its equity to lend internal debt to the other related affiliates. Moreover, it charges them user fees for a fixed factor (e.g., royalties on technology) and it serves as a vendor, buying an intermediate good at the world market and reselling it with a mark-up to the productive affiliates (e.g., the Ap-

[2]When in addition taking into account that, for multinational affiliates, the average probability of running a loss is quite substantial (e.g., Norwegian based multinationals experience losses in 38% of the observations), it is even more surprising that none of the three fields took this issue.

ple Sales International case, see Levin and McCain, 2013). Thus, our model captures profit shifting by transfer pricing both in intangibles and in intermediate goods as well as internal debt shifting. Shocks on the sale price of the final good introduce the risk to end up with net operating losses at the end of the tax year. To focus on the effects of (in-)flexibility of reverting earnings-management strategies during the tax year, we assume central decision making by the headquarters. This assumption neglects both the incentive role of transfer prices on management in decentralized units and its interaction with the tax aspect of transfer pricing.[3] But, it allows to isolate how flexibility influences the cost structures of affiliates that are ex ante identical, but, ex post, report net operating losses and profits, respectively. One justification is that firms can always rely on two books and multiple transfer prices in order to separate the tax-driven earnings management from handling principal-agent problems in a decentralized trust structure (cf. Smith, 2002; Nielsen and Raimondos-Møller, 2012). Furthermore, from the economics literature, it is well-known that centralization becomes the dominant strategy when tax differentials become large and tax savings important (Nielsen et al., 2008). Göx and Schiller (2007, p. 692) survey mixed empirical evidence for the use of two books, but anecdotic evidence fosters the view that big multinational companies that are very tax efficient (aggressive) operate with multiple transfer prices.[4]

From our model, we derive three testable hypothesis: (H1) Multinationals' affiliates should consistently report lower profits and lower losses, respectively, than comparable domestic firms, i.e., multinationals' affiliates bunch around zero profitability. (H2) Under full flexibility in reverting earnings-management decisions during the tax year ('ex-post profit shifting'), all multinational affiliates will report roughly zero profits. However, otherwise comparable multinationals' affiliates with the same output level, will disclose high transfer payments and a high internal leverage when running net operating profits, and will report low transfer payments and no internal debt when they face net operating losses. (H3) If there is no flexibility in earnings management and all final tax decisions need to be settled at the beginning of the tax year ('ex-ante profit shifting'), otherwise comparable affiliates of multinationals will report different profitability levels (i.e., significant profits or losses), but will disclose the same transfer

[3]See Göx and Schiller (2007) for an overview on these aspects. This assumption is not made because we believe that the incentive role is not important. But, for the comparison of ex-post differences in ex-ante identical affiliates, allowing for decentralization would add complexity without producing additional insights on the tax incentives.

[4]A point in case here is General Electrics. See Daniel Kocieniewski on 'G.E.'s Strategies Let It Avoid Taxes Altogether' in The New York Times of March 24, 2011, and informal statements by General Electric's Treasury officials.

price payments and internal leverage.

Using a firm-level panel data set including all Norwegian based firms, we are able to test several implications of the theoretical model. First, by comparing multinationals to domestic firms, we confirm that multinationals to a larger extent bunch around zero. Second, we conduct a regression analysis to test whether or not firms have flexibility to adjust ex post (consistent with H2) or must commit to an ex-ante strategy (consistent with H3). This is done by regressing internal transfer payments and internal leverage on a dummy variable equal to one if the firm experiences a loss position in that year. If being in a loss position significantly reduces internal leverage and transfer payments from the Norwegian affiliate, this indicates flexibility to shift ex post. Ex ante expectations are controlled for by including both the lagged loss position, which is strongly correlated with the present status, and an interaction-term variable that captures whether the firm was in a loss position both at time t and $t-1$.

The results indicate that multinationals have the possibility to adjust their transfer pricing ex post.[5] Hence, with respect to transfer pricing, we find clear support for H2. For internal leverage, we obtain the expected sign, but the effect from being in a loss position is insignificant. Thus, H3 seems to be closer to reality in the case of internal leverage. Note that, since less outgoing transfers and less leverage reduce the risk of experiencing a loss, our estimates may suffer from an attenuation bias. Therefore, it is still possible that firms have some flexibility to also adjust internal leverage ex post. But, there should be a least quite some rigidity in internal capital structures, and transfer pricing is the more flexible instrument of the two profit-shifting devices.

Governments in high-tax countries are concerned about an erosion of their tax base by profit shifting of multinational firms into low-tax countries. De Simone and Seidman (2013) conclude that tax authorities should not only focus on transactions of profitable affiliates in high-tax countries with related parties in low-tax countries but should also scrutinize transactions to unprofitable affiliates in other high-tax countries as these affiliates' effective tax rate is zero. In our model this behavior corresponds to firms that are flexible in reverting their earnings management strategies. However, less flexible firms also engage in tax planning and might be just as aggressive even though they sometimes report profits and losses. Taking into consideration that debt shifting is seen as a major channel to shift profits out of a high-tax country, it would be imprudent

[5] Consistent with findings in Dischinger et al. (2014), we find that there are important differences between multinationals' affiliates, controlled from abroad, and (Norwegian) parent companies. We point out that flexibility is more important for daughter companies.

just to focus the audit on those firms whose profits bunch around zero as tax revenue losses could be quite substantial from tax planning of inflexible firms.

We contribute in at least four ways to the literature. *First*, there is, as said, a small literature that analyzes profit shifting under losses. Klassen et al. (1993, section 4.1) discuss distinctive features of affiliates with net operating losses and point out that there is an incentive to shift in profits into such affiliates. But, the authors decide to drop loss-making affiliates in their main sample, instead of testing for their characteristics. [6] Using indirect evidence from IRS panel data on US companies from 1980 to 1987, Grubert et al. (1993) suggest that roughly 50% of the return-rate difference between foreign- and domestically controlled firms needs to be attributed to tax-induced transfer pricing and earnings management. In chapter 7.4, the authors point out that foreign-controlled firms not only disclose significantly less taxable income, but also consistently achieve to have their profitability bunched around zero, with significantly less deviations compared to domestic firms. This is taken as clear evidence for active earnings management and profit shifting.[7] Closest to the analysis of this chapter is de Simone and Seidman (2013) who focus on profits shifted to unprofitable affiliates of multinationals and who recognize that there are adjustment costs. Utilizing the Amadeus data base, they analyze independent and affiliated European firms over the period from 2002 to 2011. The authors not only find strong evidence for a bunching around zero profitability, but also that, besides risk-sharing motives, tax factors explain the profitability difference between domestic firms and multinationals' affiliates. Particularly adjustment costs, instrumented by the statutory tax rate, have a strong effect on the reduced loss reporting in multinationals relative to domestic firms.[8]

We confirm the finding of bunching around zero profits in multinationals' affiliates and extend this literature by pointing out that flexibility in reverting the tax-avoidance mechanisms matters for the extend of this bunching. By comparing intra-company

[6] This became the dominant strategy in (almost) all papers on both transfer pricing and debt shifting in order to, apparently, avoid any bias from reversed incentives under net operating losses.

[7] Maydew (1997) points out that, on the contrary, there can be an incentive to report high losses also in multinational affiliates if these net operating losses can be settled immediately against taxable income from previous tax years. He finds evidence of such loss-carryback behavior for US firms in the years after the 1986-tax reform that reduced corporate taxes substantially. However, the availability of loss carrybacks has been massively limited both in magnitude and in time (mostly to one year only now) in the last 15 years, at least in European countries.

[8] Furthermore, both Gramlich et al. (2004) and Onji and Vera (2010) analyze profit-shifting behavior within domestic Japanese trusts ('keiretsus') and find evidence that net operating losses in some Japanese affiliates are balanced by shifting in profits from other Japanese affiliates. Onji and Vera credit this behavior to tax motives that arise from the fact that the Japanese corporate income tax did not provide group provision in order to consolidate keiretsus' overall taxable income.

transfer payments and internal interest expenses between otherwise identical loss-making and profitable affiliates of multinationals, our approach allows to test directly for flexibility in income shifting and sheds light onto the question to which extend multinationals can actually adjust their earnings management ex-post. Based on our empirical findings, affiliates that can do a lot of transfer pricing can balance losses better than affiliates that must mainly rely on thin-capitalization because they neither have large internal sales nor royalty/patent payments.

Second, the finance literature reports a significant rigidity in capital structures so that they cannot be easily adjusted to changed environments. Fischer et al. (1989) argue that firms will only adjust to their target capital structure when the losses from a sub-optimal leverage are getting larger than the costs of adjusting. Particularly financially distressed (e.g., loss making) firms face high costs of adjusting their overleveraged external debt-to-asset ratios and linger around longer with their suboptimal capital structure (e.g., Gilson, 1997; Strebulaev, 2007). Reasons are hold-out problems (no enforcement in settlement) and regulatory disincentives for institutional lenders to turn their debt into equity. Korteweg (2010, section 5C) summarizes this discussion and, using a new strategy to identify net benefits of debt financing, provides evidence for significant costs of suboptimal capital structures. Thereby, the costs of being overleveraged are much higher. Moreover, Korteweg reports evidence that firms are underleveraged on average.

Our empirical results on the inflexibility of (internal) debt-to-asset ratios support this view. Even a strong tax incentive (i.e., a drop from a 28% tax rate to an effectively zero tax rate) does not induce a change in the capital structure during the tax year. Hence, the short-term rigidity seems to be substantial. Furthermore, the lagged adjustment also applies to internal debt that should neither suffer from transaction costs related to agency costs nor from costs of renegotiating with external lenders. Finally, a strategic underleveraging could be driven by taking into account the loss probabilities under ex-ante decision making.

Third, although the effects from tax debt shields on external and internal debt shifting are always highly significant, the estimated magnitudes in studies such as Desai et al. (2004), Huizinga et al. (2008), Egger et al. (2010), Møen et al. (2011) or Büttner and Wamser (2013) are surprisingly low. The estimates for the semi-elasticity of internal debt lie between 0.69 and 1.3; for external debt the range is between 0.34 and 0.69. Still, debt shifting is seen as an important channel to shape earnings disclosures and tax payments, and the limited effects are perceived as kind of a puzzle in this literature.

Büttner and Wamser suggest that the adjustment costs of the capital structure should be very high. They also find that minority ownership reduces the tax-rate sensitivity of debt, but point out that this effect is not strong enough to solve the puzzle.

Our results indicate now an additional reason for the low tax-rate sensitivities. All the studies base their estimations on tax differentials between statutory tax rates. When firms are forced to anticipate potential losses ex ante, however, the correct tax rate differential will be the expected tax rate differential which can be significantly lower. Consequently, by overestimating the decision-relevant tax differential, the debt-shifting studies to date underestimate the impact of debt tax shields on capital structures. To put it differently, the standard procedure of excluding (or controlling for) loss-making affiliates does not heal the problem, because even profitable affiliates will have adjusted their capital structure to the (ex-ante) risk of running losses.

Fourth, we suggest an additional explanation for the empirical findings of strong tax impacts in the transfer-pricing literature. For a long time, it was difficult to properly identify the effect of transfer pricing on profit differentials.[9] Coming up with first direct evidence, Oyelere and Emmanuel (1998) point out that foreign-owned affiliates in the UK are characterized by lower profits but higher dividend distributions (than UK-controlled firms). Their findings confirm significant profit shifting by foreign-controlled affiliates and directly identify transfer pricing as major driving force for this. Pak and Zdanowicz (2001) and Bernard et al. (2006) calculate that the absolute losses in US tax revenues, stemming from transfer pricing by US multinationals, are massive. Bartelsman and Beetsma (2003) study OECD data and point out that the additionally earned tax revenue, stemming from a unilateral tax increase, would be by a factor three to eight higher if profit shifting by transfer pricing could be shut down. Studies such as Swenson (2001), Clausing (2003) and Langli and Saudagaran (2004) confirm the strong impact of transfer pricing. Conventional wisdom in the literature is that it is easier to shift large amounts of profits by mispricing intra-firm trade than to rely on thin capitalization (and potentially low interest rates) for reducing the tax burden. Furthermore, transfer pricing is seen to cause less concealment costs, because it is more difficult to enforce the arm's-length principle for transfer prices than to

[9] Most, and particularly the earlier, studies only provide indirect evidence by showing that profitability substantially differs between domestic and multinational firms and that these differences should be explained by profit shifting (transfer pricing). See, e.g., Grubert and Mutti (1991), Harris (1993), Klassen et al. (1993), Hines and Rice (1994), Collins and Shackelford (1995), and Jacob (1996).

enforce effective thin-capitalization rules.[10]

Based on our findings, some part of the (comparably) high tax-differential sensitivity of transfer pricing could be explained by the fact that transfer pricing provides sufficient flexibility to adjust the earnings management during the tax year. For transfer pricing, multinationals do not need to take into account the loss probability too much and the expected tax rate differential matters less. Hence, the empirical studies on transfer pricing suffer less than the debt-shifting literature under using an 'incorrect' tax differential – and excluding loss-making firms indeed eliminates (at least to a larger extend) incentives of reverting profit-shifting channels in case of losses.

The outline of the chapter is as follows. In section 3.2, we set up the theoretical model and derive some predictions on firm behavior that can be empirically tested. A description of the data set and descriptive statistics are provided in section 3.3. In section 3.4, we outline the empirical strategy, report our empirical findings and provide a discussion of the results. Finally, we offer some concluding remarks in section 3.5.

3.2 The model

3.2.1 The setting

Consider a multinational firm (henceforth MNC) that has affiliates in n countries. Let be country 1 the country with the lowest tax rate so that $t_i > t_1, i = 2, ..., n$. As a simplification, we assume that the affiliate in the low-tax country (e.g., a tax haven) acts exclusively as a financial center of the MNC and therefore does not produce any goods. All other affiliates use capital K_i and an intermediate good S_i to produce a homogenous final good y_i according to the production technology $y = F(K_i, S_i; \bar{X})$, which is concave in both inputs. The price p_i of the final good is stochastic and drawn from a cumulative distribution function $H(p)$ with support on $[\underline{p}, \bar{p}]$. $\bar{X}$ represents a fixed factor that we interpret as acquired technological know-how (e.g., resulting from R&D investment within the MNC group).

The financial center purchases the intermediate good $S = \sum_i S_i$ at marginal costs of q_S on the world market and re-sells it at price $G_i^S + q_S$ to the other affiliates, pretending

[10] Another indirect evidence for the strong impact of transfer prices on tax avoidance is provided in Lohse and Riedel (2013). Analyzing European multinationals, they point out that tightening the documentation rules for transfer prices substantially reduces profit shifting and pays-off for tax authorities, even though the administrative burden of this regulation is high.

that it has added value to the input good. The correct arm's-length price of S, however, is q_S. Furthermore, the patent rights for the technological know-how $\bar{X}$ are also located in the profit center which claims license fees $G_i^X + q_X$, while the true arm's-length price is q_X. Any deviation from the true arm's-length price leads to convex concealment costs $C^P(P_i^X, P_i^S)$, where $P_i^X = G_i^X \cdot X$ and $P_i^S = G_i^S \cdot S_i$, with $\frac{\partial C^P}{\partial G_i^a} > (<)0$ if $G_i^a > (<)0$ and $\frac{\partial^2 C^P}{\partial (G_i^a)^2} > 0, a = \{X, S\}$. The concealment costs are defined over shifted profits and correspond to the set up in Allingham and Sandmo (1972), where a fine is calculated based on undeclared income. This concept of concealment costs in transfer pricing mirrors the 'comparable profit method' proposed by the OECD.[11]

The headquarters (henceforth HQ) of the MNC endows the financial center with equity E_1 and provides the producing affiliates with the equity necessary to reach both a tax-efficient financing structure and the optimal level of real capital. Thus, productive capital K_i in affiliate 2 is financed by equity E_i provided by the HQ and by internal debt D_i^I borrowed from the financial center so that $K_i = E_i + D_i^I$.[12] The financial center uses its equity E_1 to finance its internal lending $\sum_i D_i^I$ to all the other affiliates so that $E_1 = \sum_i D_i^I$. For expositional purposes, we define the leverage ratio of the producing affiliate as $b_i = D_i^I / K_i$ and assume that both types of finance are free of risk and carry the world-market interest rate r.

In line with most tax systems, we assume that the costs of equity are not tax deductible whilst interest expenses related to debt can be deducted from the corporate tax base. As is standard in the literature (e.g., Mintz and Smart, 2004; Schindler and Schjelderup, 2012), the MNC needs to incur concealment costs $C^I(b_i)$ in order to conceal thin capitalization. These costs are proportional to the amount of capital employed and convex for any positive internal leverage $b_i > 0$, but zero otherwise (i.e., $C^I(b_i) = 0$ for $b_i \leq 0$).

Given these assumptions, the economic profit of affiliate i is given by revenue from the sales of the output good minus the licences cost, the cost for the intermediate good and the user cost of capital

$$\pi_i^e = p_i y_i - (G_i^X + q_X)\bar{X} - (G_i^S + q_S)S_i - C^P(P_i^X, P_i^S) - C^I(b_i)K_i - rK_i. \quad (3.1)$$

[11] The alternative approach would be to rely on the deviation of the true arm's-length price only, featuring the 'comparable unrelated price method,' see OECD (2013) and Gresik and Osmundsen (2008) for institutional details. Qualitatively, our results do not depend on which approach is chosen.

[12] For simplicity and without any consequences for our main results, we have assumed that there are no external capital markets for debt available.

Taxable profit differs from economic profit in that opportunity costs of equity and concealment costs are not tax-deductible. Furthermore, we assume that no loss offset is granted when the affiliate is running taxable losses. Hence, if the realization of the output price p_i is too low, the government does not participate in the resulting losses and the tax payments are zero.[13] Let p_i^0 be the price for which the taxable profit of affiliate i is just zero. The taxable profit of affiliate i can then be written as

$$\pi_i^t = \begin{cases} p_i y_i - (G_i^X + q_X)\bar{X} - (G_i^S + q_S)S_i - rb_iK_i, & \text{if } p_i > p_i^0 \\ 0, & \text{if } p \leq p_i^0. \end{cases}$$

The surplus of the financial center in country 1 amounts to

$$\begin{aligned} \pi_1 &= (1-t_1)\bar{\pi} + (1-t_1)\sum_i (G_i^X + q_X)\bar{X} + (G_i^S + q_S)S_i + rb_iK_i - q_X\bar{X} - q_S S_i] - rb_iK_i \\ &= (1-t_1)\bar{\pi} + (1-t_1)\sum_i G_i^X\bar{X} + G_i^S S_i - t_1 r \sum_i b_i K_i. \end{aligned} \tag{3.2}$$

Hereby, $\bar{\pi} > 0$ represents positive exogenous profits in the financial center.[14]

The HQ of the MNC maximizes total after-tax profits Π by choosing the optimal tax-avoidance activity, i.e., by optimizing over leverages b_i, and the transfer prices G_i^X and G_i^S. With respect to the timing of the tax planning strategies of the MNC, two scenarios are applicable. Firstly, the MNC could choose its tax-planning strategies after the realization of the output price, say, at the end of the year. We will refer to this scenario as 'ex-post profit shifting.' Secondly, it could be that the MNC has to decide on and to commit to its profit-shifting activities before the revelation of the output prices. We will refer to this setting as 'ex-ante profit shifting.'

[13]In reality, loss carry forwards imply that current losses can be deducted against future profits. However, loss carry forwards are not inflated with interest so that the present discounted value decreases. Therefore, our simplifying assumption of no loss offsets is harmless, because multinationals always have the incentive to settle losses in one affiliate with taxable profits in other affiliates.

[14]In a full-fledged model, there would be other (profitable) affiliates that shift profits to the financial center. In order to account for that and to make sure that the multinational can shift profits to the high-tax affiliates in case of taxable losses in these affiliates, we assume $\bar{\pi} > 0$ as a shortcut.

3.2.2 Ex-post profit shifting

Ex-post the MNC knows about the realization of the output prices p_i. Taking this into consideration, the MNC optimally shifts income into the affiliates that give the higher effective reduction in tax payments. We can distinguish the two cases $p_i > p_i^0$ and $p_i \leq p_i^0$.

Positive taxable profits. In the first case, the producing affiliates makes economic profits and therefore face the local tax rate t_i. The overall profit of the MNC can be written as

$$\begin{aligned} \max_{b_i, G_i^X, G_i^S} \Pi = \quad & \pi_1 \quad + \sum_i \pi_i^e - t_i \pi_i^t \\ \text{s.t.} \quad & \pi_i^t \quad > 0, \\ & \textstyle\sum_i \quad r b_i K_i = 0, \quad \sum_i G_i^X \bar{X} = 0, \quad \sum_i G_i^S S_i = 0. \end{aligned} \tag{3.3}$$

Differentiating the total after-tax profits for the three tax-avoidance variables and considering λ_i as the Kuhn-Tucker multiplier yields

$$t_i - t_1 - \frac{1}{r} \frac{\partial C^I}{\partial b_i} \leq \lambda_i, \tag{3.4a}$$

$$t_i - t_1 - \frac{\partial C^P}{\partial P_i^X} \leq \lambda_i, \tag{3.4b}$$

$$t_i - t_1 - \frac{\partial C^P}{\partial P_i^S} \leq \lambda_i, \tag{3.4c}$$

where the first-order conditions hold with equality and $\lambda_i = 0$ if $\pi_i^t > 0$.

The first-order conditions state that the effective marginal concealment costs for each profit shifting device equalize in the optimum, i.e. $\frac{1}{r}\frac{\partial C^I}{\partial b_i} = \frac{\partial C^P}{\partial G_i^X} = \frac{\partial C^P}{\partial G_i^S}$. Furthermore, if the taxable profit in the producing affiliates is positive, the MNC is unconstrained in the use of all profit shifting channels ($\lambda_t = 0$) and effective marginal concealment costs are equal to the marginal tax savings $t_i - t_1$. The consequences are that the MNC sets transfer prices above the correct arm's-length prices, and that the financial center lends internal debt to the high-tax affiliates in order to shift profits into the tax haven.

Non-positive taxable profits. Whenever the output price is equal to or below the break-even price ($p_i < p_i^0$), the producing affiliates have neither economic nor taxable profits. Therefore, their tax payments drop to zero. The overall profits of the MNC can be written as

$$\begin{aligned} \max_{b_i, G_i^X, G_i^S} \Pi = \quad & \pi_1 \quad + \sum_i \pi_i^e \\ \text{s.t.} \quad & \pi_i^t \quad \leq 0, \\ & \textstyle\sum_i \quad r b_i K_i = 0, \quad \sum_i G_i^X \bar{X} = 0, \quad \sum_i G_i^S S_i = 0. \end{aligned} \tag{3.5}$$

The optimization problem is similar to the case with positive taxable profits and yields

$$t_1 + \frac{1}{r} \frac{\partial C^I}{\partial b_i} \geq \lambda_i, \tag{3.6a}$$

$$t_1 + \frac{\partial C^P}{\partial P_i^X} \geq \lambda_i, \tag{3.6b}$$

$$t_1 + \frac{\partial C^P}{\partial P_i^S} \geq \lambda_i, \tag{3.6c}$$

where for the Kuhn-Tucker parameter holds $\lambda_i = 0$ if $\pi_i^t \leq 0$.

Once more, the first-order conditions state that the effective marginal concealment costs for each profit shifting device are equalized in the optimum. In the case of taxable losses ($\pi_i^t < 0$), the effective marginal concealment costs, in absolute terms, equal the marginal loss $-t_1$ from shifting out profits. Accordingly, the MNC has an incentive to reduce the transfer price for the intermediate good as well as for the licence fee below the correct arm's-length price.[15] Moreover, the internal debt tax shield in affiliate i becomes negative and internal debt will drop to zero. Actually, the MNC has even an incentive to use the high-tax affiliates as internal bank as long as these affiliates are in a loss position and their effective tax rate is zero. We will, however, assume that the MNC cannot reallocate its equity. For tax savings, the total interest deduction over the entire tax year matter so that an inverted financial structure at year's end will not deliver any reward. In sum, the MNC shifts profits into the high-tax countries which means that the incentives for profit shifting are completely reversed in a loss position.

[15]Implicity, we assume that there are no concealment costs related to shifting profits out of a tax haven, because the tax haven does not monitor the financial flows.

Tax-efficient capital structure. The mechanism at play under debt shifting is that interest income is earned in the low-tax country and deducted in high-tax countries so that the tax savings arising from the deductions in high-tax countries exceed the corresponding tax payments in the low-tax country.

Following the empirical debt-shifting literature (e.g., Huizinga et al., 2008, Møen et al., 2011), we assume concealment costs of (internal) debt to be quadratic in leverage, i.e.,

$$C^I(b_i) = \frac{\eta_b}{2} \cdot (b_i)^2 \tag{3.7}$$

η_b represents a constant cost parameter of debt shifting. Applying equation (3.7) in the first-order condition (3.4a), we find as optimal internal leverage in the case of a profitable producing affiliate

$$b_i^* = (t_i - t_1)\frac{r}{\eta_b} > 0. \tag{3.8}$$

All affiliates $i > 1$ will borrow internal debt from the financial center and, due to improved possibilities to save taxes, the internal leverage is increasing in the internal tax debt shield, that is

$$\frac{\partial b_i}{\partial t_i} = \frac{r}{\eta_b} > 0 \quad \text{and} \quad \frac{\partial b_i}{\partial t_1} = -\frac{r}{\eta_b} < 0.$$

If taxable profits are negative instead, the affiliate experiences a negative debt tax shield $(-t_1 r)$ and the optimal internal leverage is zero in affiliates that are in a loss position $\pi_i^t < 0$.

Optimal transfer pricing. As for debt shifting, the literature on transfer pricing suggests quadratic concealment costs (e.g., Haufler and Schjelderup, 2000; Grubert, 2003; Nielsen et al., 2010). Since the MNC in our model has two devices for shifting profits by transfer pricing, G_i^X and G_i^S, it is reasonable to consider the two as cost substitutes, i.e., the two devices are mutually increasing each others' concealment costs. We define the concealment cost function of profit shifting as

$$C^P(P_i^X, P_i^S) = \frac{1}{2}\left[\frac{\eta_X}{2}\left(P_i^X\right)^2 + \frac{\eta_S}{2}\left(P_i^S\right)^2\right]^2. \tag{3.9}$$

Using (3.9) as the cost function leads to the following optimal (abusive) transfer prices for the licence fee and the intermediate good[16]

$$\left(G_i^X\right)^* = \sqrt[3]{\frac{\eta_S}{\eta_S + \eta_X} \cdot \frac{2}{(\eta_X)^2} \cdot (\mathbb{1} \cdot t_i - t_1)}\ \frac{1}{\bar{X}}, \quad \mathbb{1} = \begin{cases} 1, & \text{if } \pi_i^t > 0 \\ 0, & \text{if } \pi_i^t \leq 0. \end{cases} \tag{3.10a}$$

$$\left(G_i^S\right)^* = \sqrt[3]{\frac{\eta_X}{\eta_S + \eta_X} \cdot \frac{2}{(\eta_S)^2} \cdot (\mathbb{1} \cdot t_i - t_1)}\ \frac{1}{S_i}, \quad \mathbb{1} = \begin{cases} 1, & \text{if } \pi_i^t > 0 \\ 0, & \text{if } \pi_i^t \leq 0. \end{cases} \tag{3.10b}$$

Not surprisingly, the surcharge on the correct arm's-length prices is positive in case of a profitable affiliate ($G_i^X, G_i^S > 0$). In this case, the mark-up increases with the tax rate of the producing affiliates t_i , but decreases with the tax rate t_1 of the financial center

$$\frac{\partial G^a}{\partial t_i} > 0 \quad \text{and} \quad \frac{\partial G^a}{\partial t_1} < 0, \quad a = X, S.$$

A higher tax differential makes transfer pricing more attractive, because shifting profits will result in higher tax savings.

In contrast, the MNC sets a transfer prices that lies below the correct arm's-length price if the affiliate is in a loss position ($G_i^X, G_i^S < 0$). This is because the effective marginal tax rate is zero, regardless of t_i. Consequently, profit-shifting incentives are reversed as long as the producing affiliates have non-positive taxable profits (i.e., zero tax payments). In this case, the tax rate t_i does not affect the magnitude of the transfer prices. Contrary to before, an increase of the tax rate t_1 in the profit center leads to a decrease in the transfer prices and to more profits shifted to the producing affiliates, now. The reason is that the tax disadvantage of the tax haven relative to the effectively zero tax burden in the high-tax countries increases.

Putting both aspects together, affiliates of MNCs are bunching around zero taxable profits. For profitable affiliates, the HQ has an incentive to shift profits into the low-tax country, whereas affiliates with taxable losses in the operating business will receive profits from affiliates abroad (the financial center). For zero taxable profits, the incentives to shift coincide and collapse. Because domestic companies cannot shift profits internationally, these companies cannot buffer their operating profits and losses. Hence, the profit distribution around zero is much less compressed for domestic firms than for affiliates of MNCs. Empirical studies by Grubert et al. (1993, chapter 7.4) and by Møen and Tropina (2013) find empirical support for this result.

[16] We deliver a full derivation of the optimal transfer prices in Appendix C.1.

3.2.3 Ex-ante profit shifting

If the MNC must decide ex ante on transfer prices as well as the level of internal debt, it cannot revisit these decisions after the output prices revealed. The MNC's HQ maximizes the expected overall profits taking into consideration that the output prices p_i are stochastic and follow a cumulative distribution function $H(p)$ with support $[\underline{p}, \bar{p}]$. Then, expected profits of the high-tax affiliates are

$$\begin{aligned} E(\pi_i) &= \int_{\underline{p}}^{\bar{p}} p_i h(p)\ dp \cdot y_i - (G_i^X + q_X)\bar{X} - (G_i^S + q_S)S_i - rK_i \\ &+ [1 - H(p_i^0)] \cdot t_i[(G_i^X + q_X)\bar{X} + (G_i^S + q_S)S_i + rb_iK_i] \\ &- t_i \int_{p_i^0}^{\bar{p}} p_i h(p)\ dp \cdot y_i - C^P(P_i^X, P_i^S) - C^I(b_i)K_i. \end{aligned} \tag{3.11}$$

The first line displays affiliates' economic profits. The size of the economic profits depends on the realization of p_i which is ex-ante uncertain. Additionally, affiliates have to pay taxes in the case of a sufficiently high output price. This happens only with the likelihood $[1 - H(p_i^0)]$. In any other case, tax payments in country i are zero. The MNC incurs also concealment costs for debt shifting and transfer price manipulation. Accordingly, overall expected profits of the MNC can be written as

$$E(\Pi) = \sum_i E(\pi_i) + (1 - t_1) \sum_i G_i^X \bar{X} + G_i^S S_i - t_1 r \sum_i b_i K_i. \tag{3.12}$$

Differentiating the expected after-tax profits of the MNC for the three tax-avoidance variables, taking into consideration that the price p_i^0 is affected by changes in the transfer prices and internal debt, gives[17]

$$[1 - H(p_i^0)]t_i - t_1 = \frac{1}{r} \frac{\partial C^P}{\partial b_i}, \tag{3.13a}$$

$$[1 - H(p_i^0)]t_i - t_1 = \frac{\partial C^P}{\partial P_i^X}, \tag{3.13b}$$

$$[1 - H(p_i^0)]t_i - t_1 = \frac{\partial C^P}{\partial P_i^S}. \tag{3.13c}$$

With uncertainty in the realization of the output price, the risk neutral MNC is more cautious in setting transfer prices and allocating internal loans. The MNC only wants

[17]We deliver a full derivation of the ex-ante optimality conditions in Appendix C.2.

to shift profits to the financial center if the producing affiliate has taxable profits. The probability for this case ($\pi_i^t > 0$) to happen is $1 - H(p_i^0)$. Therefore, it is the expected tax rate of the producing affiliate, $[1 - H(p_i^0)]\, t_i$, that matters for determining the tax savings ex ante. Consequently, overinvoicing transfer prices and internal debt shifting becomes less attractive if the probability of being unprofitable, $H(p_i^0)$, increases.

3.2.4 Theoretical predictions

To summarize, the theoretical model offers several predictions, some of which we are able to test empirically. Firstly, in line with the existing literature (Grubert et al., 1993; de Simone and Seidman, 2013), the model predicts that, compared to purely national firms within the same industry, affiliates of MNCs should have lower tax payments if the affiliate is profitable. Analogously, affiliates of MNCs should report lower taxable losses than comparable purely national firms. In both cases, the reason is that MNCs can adjust their transfer prices and the financial structure to shift profits tax efficient between countries. We summarize this finding in:

Hypothesis 1 *High-tax affiliates should have lower tax payments (lower losses) when running profits (losses) as compared to national firms.*

Secondly, we should expect that tax payments of high-tax affiliates are bunching around zero if the MNC has the possibility to adjust profit shifting strategies ex post, i.e., at the end of the year when the actual output price p_i is known. As a result, comparable affiliates of MNCs (with the same output) will differ in their cost structures, but will all bunch around zero profits. More precisely, our model predicts:

Hypothesis 2 *Tax payments of high-tax affiliates are bunching around zero in the case of ex-post profit shifting. Otherwise comparable affiliates with the same output level, however, will under ex-post shifting feature high transfer payments and a high internal leverage if they are profitable (i.e., $\pi_i^t > 0$ before any tax avoidance operation), whereas they will carry low transfer payments and no internal debt if they are in a loss position ($\pi_i^t < 0$).*

Thirdly, if the MNC must commit to its profit-shifting strategy ex ante, we should observe differences in the profit levels of these affiliates which stem from differences in the realization of the output price. However, incentives for profit shifting are the same for all affiliates ex-ante, i.e. we should observe an identical cost and financial structure across affiliates. We summarize this in:

Hypothesis 3 *If ex-ante profit shifting is the relevant scenario, comparable affiliates of MNCs will show different profit levels (i.e., different tax payments), but will feature the same transfer price payments and internal leverage.*

Fourthly, if the probability of being unprofitable increases, we should observe a reduction in the profit shifting incentives of ex-ante profit shifters only. Incentives for ex-post profit shifters are not affected by the ex-ante probability of being unproductive since they decide on profit shifting strategies after the realization of the output price. We summarize this in:

Hypothesis 4 *An increase in the probability of being unprofitable only affects the profit-shifting behavior of MNCs that are forced to do ex-ante profit shifting.*

3.3 Data and descriptive statistics

The sample is constructed by combining three unique data sources. First, Dun&Bradstreet provides data on all financial statistics for all companies registered in Norway. Second, SIFON gives information about foreign ownership of Norwegian firms. Third, the Tax Authorities (Skattedirektoratet) has data on transactions and debt relationships between Norwegian firms and foreign affiliates (Utenlandsoppgaven). These three sources are merged, using an identification key that identifies each Norwegian firm uniquely. We classify a Norwegian firm as a MNC if it either controls at least one daughter company abroad or is controlled by a foreign owner. That is, the Norwegian firm is an MNC if it either owns, directly or indirectly, at least 50% of a foreign affiliate, or a foreign owner directly controls at least 50% of the shares of the Norwegian firm. Outgoing transfers include royalties, license fees, rental expenditures, and purchases the Norwegian firm makes from a foreign affiliate.

Our panel data covers the eight-year period from 1998 to 2005, and it includes all firms except financial firms and producers of oil and gas which are subject to special laws and regulations. The variation in the data is limited; in particular, there is not much variation in each firm's loss/profit positions over time. Therefore, we try to preserve as much as possible of the original data. We only exclude some very few observations with extreme values, notably negative sales and negative total assets. Finally, the measures for transfer prices are winsorized at the 1st percentile, while we restrict the

Figure 3.1: Distribution of results over assets before taxes

total internal leverage to the interval [0; 1].[18] Several of the control variables are also winsorized, see Appendix C.4 for details.

We start out by looking at the distribution of results before taxes of both domestic firms and MNCs in Figure 3.1. It is clear from the graphics that profits are lower for MNCs than for domestic firms. The picture is somewhat less clear for firms in a loss position, but the quantile marks indicate that MNCs to a larger extent than domestic firms bunch around break-even also when in a loss position. These observations are in line with Grubert et al. (1993) as well as De Simone and Seidman (2013), and they provide support to our first theoretical prediction (cf. Hypothesis 1 in section 3.2.4).

The theoretical model suggests that the observed bunching is due to reversed incentives for profit shifting. It is, however, uncertain how much flexibility the MNCs have when it comes to adjusting their transfer prices and internal leverage. The theoretical model offers two contrasting predictions. Hypothesis 2 states that, under ex-post

[18] 39 and 6 observations, respectively, are deleted from the sample of MNCs due to negative sales and negative total assets. 303 observations with an internal leverage outside the interval [0; 1] are excluded from the analysis of internal debt, but these are included in the study of transfer payments.

Table 3.1: Descriptive statistics.

	Average	(st.dev)		
The loss position dummy ($N = 7,457$)	0.38	(0.49)		
	Full sample	In loss position	Not in loss position	Difference
Net outgoing transfer payments				
All MNCs	-1.33	-1.06	-1.51	0.45**
(St.dev.)	(9.29)	(8.19)	(9.89)	
Number of obs.	7,457	2,829	4,628	
Norwegian daughters	0.48	-0.48	1.07	-1.55***
(St.dev)	(7.48)	(5.16)	(8.56)	
Number of obs.	821	315	506	
Total internal debt				
All MNCs	4.53	3.93	4.89	-0.96***
(St.dev.)	(14.51)	(13.50)	(15.08)	
Number of obs.	7,159	2,698	4,481	
Norwegian daughters	4.68	3.17	5.61	-2.44**
(St.dev)	(15.32)	(12.45)	(16.79)	
Number of obs.	789	300	489	

Transfer payments and internal leverage are standardized as % of the firm's average total assets over the time period.
*** p<0.01, ** p<0.05, * p<0.1

shifting, affiliates with the same output level will feature high transfer payments and a high internal leverage if they are profitable (i.e., $\pi_i^t > 0$ before any tax-avoidance operation), whereas they will carry low transfer payments and no internal debt if they are in a loss position ($\pi_i^t < 0$). Hypothesis 3 considers the low-flexibility situation where MNCs have to commit to profit-shifting strategies ex ante. If this is the correct scenario, we should observe differences in the profit levels of these affiliates which stem from differences in the realization of the output price. However, incentives for profit shifting are the same for all affiliates ex-ante, i.e. we should observe an identical cost and financial structure across affiliates.

Actually, we would like to test Hypothesis 4 on the effect of an increase of the loss probability empirically, as well. But, our data set provides us with too little variation and information to do so. Therefore, the remainder of the empirical analysis seeks to identify which of the two hypothesis H2 vs. H3 is most correct, i.e., to which extent profit-shifting strategies are functions of whether or not the affiliate experiences a loss. In order to study this, we generate a dummy variable (L_{it}) equal to 1 if the Norwegian firm i is in a loss position in year t.

Table 3.1 takes a first, descriptive look at the relationship between being in a loss position and profit-shifting strategies. In order to adjust for firm size, we standardize the transfer payments and leverage by the firm's (i.e., Norwegian affiliate's) mean total assets over the period. Using the mean total asset in the denominator secures that any changes in the dependent variable are caused by changes in profit shifting rather than in the denominator.

Table 3.2: Autocorrelation in loss positions

Loss position at time t	Correlation
Loss position at time $t-1$ ($N = 6,605$)	0.41***
Loss position at time $t-2$ ($N = 5,746$)	0.28***

*** p<0.01, ** p<0.05, * p<0.1

First, we note that firms experience losses in a substantial number of cases, as much as in 38% of our observations. In contrast to what theory predicted, we observe that MNCs in a loss position have higher net outgoing transfers when studying the full sample of MNCs.[19] This is a puzzle, but recent findings by Dischinger et al. (2014) offer a plausible explanation. They find that the profit distribution is skewed in favor of the headquarter's location. This indicates that the headquarter plays a special role in the MNCs, or to quote the title of their paper "There is no place like home". Moreover, their results are well grounded in theory that points to agency costs and moral-hazard problems between the headquarters and the profit center/internal bank.[20] Hence, we also look at the sub-sample of MNCs that are controlled by foreign owners, i.e., at daughter companies only. For that sub-sample, we get the expected negative sign, and the difference is also clearly statistically significant.

The difference between the full sample of MNCs and the Norwegian daughters is less dramatic when looking at internal leverage. In both cases, it seems that firms in a loss position hold less debt than those in a break-even or profit position. However, the difference is larger for the sub-sample of daughters. These differences seem to suggest that there is flexibility in both devices for tax avoidance. However, it would be premature to draw any conclusion at this stage. In order to discuss causality, a more rigorous econometric procedure, which deals with a number of empirical challenges, is required.

A first concern is the potential for autocorrelation in performance. If losses in previous years are a good indicator of the probability of running losses also at time t, firms can adjust their strategies based not only on present, but also on past performance. Failing to control for such dynamic adaptions will give rise to an omitted variables bias.

We report the autocorrelation in Table 3.2. It is evident that being in a loss position in one year is a strong predictor of the performance also in the next year, and even in the next few years to come. Therefore, this should be taken into account when establishing

[19] Net outgoing transfers is defined as outgoing transfer payments less incoming transfer payments. Consequently, positive values imply that the Norwegian affiliate pays out more transfers than it receives.

[20] See, e.g., O'Donnel (2000), Chang and Taylor (1999), and Hamilton and Kashlak (1999).

the empirical model.

3.4 Empirical analysis

3.4.1 Empirical strategy

According to the theoretical model, the profit-shifting strategy should be a function of the tax differential between Norway and the tax haven, and the loss position (given ex-post shifting) or the expectation of experiencing a loss (given ex-ante profit shifting). The empirical investigation thus relies on OLS estimations of variations of the equation

$$y_{ijt} = \beta_0 + \beta_1 L_{ijt} + \beta_2 L_{ijt-1} + \beta_3 L_{ijt} * L_{ijt-1} + \kappa t^l_{ijt} + \boldsymbol{z'_{ijt}\theta} + \delta_t + \alpha_j + \epsilon_{ijt} \quad (3.14)$$

where the dependent variable y_{ijt} is transfer payments or internal leverage in affiliate i, being active in industry j at year t.[21] In the main specifications, we use net outgoing transfers and total internal leverage, but we will also report results from regressions on gross incoming and outgoing transfers, as well as short-term and long-term internal leverage.

L_{ijt} is the loss-position dummy, giving that β_1 is the coefficient of most interest in our study. According to our Hypothesis 2, β_1 should be significantly negative if firms have the flexibility to adjust their profit shifting ex post. If the ex-ante scenario is relevant, however, it follows from Hypothesis 3 that β_1 should be zero and insignificant, because firms must commit to their transfer payments and leverages, respectively, at the beginning of the tax year. Being in a loss position should not have any influence in the latter scenario.

As discussed above, the substantial autocorrelation in losses gives that earlier years' performance is an important control for the expectations on performance in year t. Moreover, this expectation can have a direct impact on how a firm reacts to losses in year t. Hence, we include the lagged loss position and an interaction term between the present and lagged loss position in the regressions. The interaction term gives a new dummy that is equal to one if a firm experienced a loss position both at time t and

[21] Following our theoretical approach, we have tried to run the empirical analysis while splitting the transfer payments into the categories royalties, license fees, rental expenditures on the one hand and purchases (cost of materials) on the other hand. But, this reduces the variation in the data too much and no meaningful results can be obtained.

$t-1$. By doing so, we try to control for the expectations on the loss probability $H(p_i^0)$, being relevant in the ex-ante shifting scenario, cf. equations (3.13a) to (3.13c). Next, t_{ijt}^l is the tax rate in the foreign affiliate with the lowest tax rate (i.e., the 'tax haven'), capturing the maximum tax rate differential.

$\boldsymbol{z_{ijt}}$ is a vector of control variables and includes several key characteristics of the firm. The choice of control variables is motivated by earlier literature on profit shifting, see, e.g., Møen et al. (2013), Büttner and Wamser (2009), Huizinga et al. (2008), and Rajan and Zingales (1995). First, the result as share of total assets serves as a performance measure. Second, the loss carry forward is also a potentially important control. This variable captures loss carry forward and losses on sold assets. Thirdly, total assets and number of employees act as size measures. Fourth and finally, we include the age of the firm.[22] In addition, all regressions include for time and industry fixed effects, represented by δ_t and α_j, respectively.

In the descriptive statistics, we saw that losses seem to affect profit shifting in different manners for parent and daughter companies. This observation is consistent with findings in the literature suggesting that MNCs partially shift profits into the parent company rather than optimizing the tax structure (Dischinger et al., 2014). Hence, we will estimate the model both for all MNCs and for Norwegian firms controlled by foreign parents.

A word of warning is in place before proceeding to the results of the empirical investigation. Even when conditioning on the set of control variables, one should show caution when interpreting the coefficient for the loss-position dummy. For two reasons, the point estimates are most likely biased.

First, since the profit shifting decisions affect the probability of being in a loss position, and, thus, L_{ijt}, β_1 can be plagued by a simultaneity bias. In Appendix C.3 the bias is derived and studied formally. The conclusion is that the simultaneity gives an attenuation bias in our main results, suggesting that these are conservative estimates.

Second, the interpretation of our results depend crucially on our ability to control for relevant characteristics of the firms. Since the data does not contain enough variation to use firm fixed effects, one may fear that the results are driven by unobservable characteristics. Specifically, it is problematic that the baseline regressions compare companies with very different performances. Companies with large profits or losses can be very different from those that are close to break-even, despite being on the same

[22]Descriptive statistics for the control variables are presented in Appendix C.4.

side of zero. In order to investigate whether or not our results are sensitive to this, we will also estimate the model using sub-samples consisting only of firms close to break-even. Similar strategies for reducing problems related to unobservable characteristics have been used, e.g., by Ferraz and Finan (2008) and Hopland (2014).

Given these two caveats, we do not interpret the point estimates as marginal effects from being in a loss position. Rather, we restrict ourselves to a discussion about how the direction of the effects corresponds to the predictions from the theoretical model and to which extent the estimated effects appear robust.

3.4.2 Results

Table 3.3 presents the main results for transfer-pricing strategies. In Column (A) we include all Norwegian based MNCs in an estimation of net outgoing transfers. We remember from the descriptive statistics that the raw difference came out with an unexpected positive sign. When adding the control variables in a regression framework, we obtain the expected negative sign for the loss position, but the coefficient is not significant at any conventional level of significance. Moreover, the overall explanatory power is very weak, and only the number of employees comes out as significant. Consistent with the findings in Dischinger et al. (2013), we assume that the low explanatory power, at least to some extent, is owing to the behavior of Norwegian parent companies. Thus, we devote Columns (B)-(D) to a study of Norwegian daughter companies.

Column (B) is similar to Column (A), the sample being the only difference. In the descriptive statistics, we found a statistically significant raw difference of -1.55. When conditioning on the control variables, the effect from being in a loss position is even stronger, with a coefficient of close to -2.5. Perhaps somewhat surprisingly, none of the control variables comes out as significant. This is probably due to the limited variation in net outgoing transfers. Of the 604 observations in the regressions, close to 500 take the value zero, while the remaining observations are almost evenly distributed between positive and negative.

In Columns (C) and (D), we split the net outgoing transfers and study gross outgoing and gross incoming transfers separately. A first observation is that our model explains much more of the variation in outgoing transfers than for the incoming transfers. Moreover, we observe that the effect on net outgoing transfers is entirely driven by a reduction in gross outgoing transfers, while the incoming transfers remain unchanged.

Table 3.4 presents the results for internal leverage. As when studying transfer pay-

Table 3.3: Estimation of transfer pricing strategies.

VARIABLES	(A) All MNCs Net outgoing transfers	(B) Net outgoing transfers	(C) Norwegian daughters Gross outgoing transfers	(D) Gross incoming transfers
Loss position at time t	-0.162	-2.491**	-2.423**	0.446
	(0.457)	(1.165)	(1.211)	(0.711)
Loss position at time $t-1$	0.0848	-1.021	-1.587	-0.163
	(0.393)	(0.788)	(0.992)	(0.407)
Loss position both	0.743	-0.1000	-0.0700	0.384
at t and $t-1$	(0.658)	(1.273)	(1.793)	(0.689)
Results as share of	-0.221	-0.813	-0.707	0.0174
total assets	(0.170)	(1.169)	(1.751)	(0.459)
Tax rate for affiliate	3.642	-5.448	-14.20	-2.580
with lowest tax rate	(3.141)	(7.437)	(12.63)	(1.999)
Total assets	-7.84e-07	-8.99e-06	-1.82e-05	4.36e-07
	(2.35e-06)	(9.84e-06)	(1.68e-05)	(1.63e-06)
Employees	-0.0142**	0.0108	0.0405	0.0112*
	(0.00625)	(0.0211)	(0.0366)	(0.00611)
Company age	0.000137	-0.0136	-0.0740	-0.0207
	(0.0131)	(0.0531)	(0.0802)	(0.0145)
Loss carry forward	0.240	-0.260	-0.218	0.00138
as share of the resul	(0.165)	(0.435)	(0.601)	(0.264)
Observations	5,405	604	604	604
R-squared	0.089	0.210	0.215	0.082

A constant term and time and industry dummies (not reported) are included in all regressions. The transfer prices are standardized as % of the firm's average total assets over the period.
*** p<0.01, ** p<0.05, * p<0.1

ments, it is reasonable to expect that it is not trivial whether a firm is a parent or daughter company. Hence, Table 3.4 has the same structure as Table 3.3, with estimations using the full sample of MNCs in Column (A), and estimations using only Norwegian daughters in Columns (B)-(D).

We remember a negative raw difference in total internal leverage from the descriptive statistics, and this sign remains in Column (A). However, when controlling for a wide set of covariates in a regression framework, the coefficient for loss position comes out as insignificant. The control variables seem to be of some more importance when estimating leverage, most likely because this variable contains more information than the transfers. As expected, the tax rate for the affiliate with lowest tax rate comes out as negative. In addition, large companies (in terms of total assets) have more internal leverage than smaller firms.

When studying the total internal leverage in Norwegian daughter companies, we also obtain an insignificantly negative coefficient for the loss-position dummy. Among the control variables, only the results as share of assets is significant, with a negative sign. Finally, in Columns (C) and (D), respectively, we report the results for splitting internal leverage into short-term and long-term leverage. The coefficient for the loss-

Table 3.4: Estimation of internal leverage.

VARIABLES	(A) All MNCs Total internal leverage	(B) Total internal leverage	(C) Norwegian daughters Short-term internal leverage	(D) Long-term internal leverage
Loss position at time t	-0.0271	-1.085	0.351	-1.436
	(0.631)	(2.331)	(1.929)	(0.880)
Loss position at time $t-1$	-0.117	-0.0966	1.419	-1.515*
	(0.624)	(2.082)	(1.736)	(0.832)
Loss position both	0.440	-3.270	-4.250	0.980
at t and $t-1$	(0.949)	(3.684)	(3.276)	(1.035)
Results as share of	0.447	-3.625**	-2.487*	-1.138*
total assets	(0.346)	(1.624)	(1.492)	(0.643)
Tax rate for affiliate	-16.64***	-0.466	-2.551	2.085
with lowest tax rate	(3.624)	(10.22)	(8.955)	(3.619)
Total assets	5.75e-06**	3.75e-06	2.06e-06	1.68e-06
	(2.31e-06)	(6.64e-06)	(5.59e-06)	(2.40e-06)
Employees	-0.00245	-0.0250	-0.0146	-0.0104
	(0.00710)	(0.0195)	(0.0137)	(0.00875)
Company age	-0.0110	-0.0727	-0.0265	-0.0462*
	(0.0147)	(0.0552)	(0.0415)	(0.0255)
Delayed tax advantage	-0.289	-0.329	-0.350	0.0207
	(0.289)	(0.862)	(0.574)	(0.451)
Observations	5,187	580	580	580
R-squared	0.151	0.220	0.178	0.214

A constant term and time and industry dummies (not reported) are included in all regressions. Internal leverage is standardized as % of the firm's average total assets over the period.
*** p<0.01, ** p<0.05, * p<0.1

position dummy is not significant at any conventional level of significance in any of the two. However, the lagged loss position comes out as negative when estimating long-term internal leverage, indicating that companies to some extent adjust leverage over time as a response to performance.

Table 3.5 presents robustness tests, where we use sub-samples close to break-even. Using these sub-samples help to reduce problems related to unobservable characteristics, since we only compare firms with similar performance. In Columns (A) and (B), we restrict the sample to companies with results over assets between the 25th and 75th percentile, i.e., we throw out the 25 highest and lowest performers in year t. In Columns (C) and (D), we go much further, and keep only companies with results over assets between -1.5% and 1.5%. We observe that the number of observations is reduced heavily in both cases.

The results for net outgoing transfers are displayed in Columns (A) and (C). Interestingly, we see that the coefficient increases compared to the baseline. When using the least restrictive cut-off in Column (A), the coefficient is about twice as large as in the baseline, while it is more than three times the size of the baseline when using the most restrictive cut-off in Column (C). As explained in the previous section, we hesitate to

Table 3.5: Estimations on sub-samples close to break-even. Only daughter companies included.

	(A) Net outgoing transfers	(B) Total internal leverage	(C) Net outgoing transfers	(D) Total internal leverage
Loss position at time t	-5.991***	-2.170	-8.910**	-10.53
	(2.268)	(3.267)	(4.215)	(11.86)
Loss position at time $t-1$	-1.486*	-0.372	0.0365	-2.663
	(0.826)	(2.372)	(0.929)	(3.605)
Loss position both	1.052	-4.778	0.797	7.542
at t and $t-1$	(1.639)	(4.886)	(2.598)	(8.763)
Results as share of	-23.98**	-23.03	-382.3**	-225.3
total assets	(11.75)	(19.64)	(185.8)	(585.5)
Tax rate for affiliate	-5.778	8.990	-11.41	-5.099
with lowest tax rate	(7.914)	(11.89)	(14.93)	(26.13)
Total assets	-9.27e-06	5.18e-06	-2.36e-05*	1.25e-05
	(1.11e-05)	(7.35e-06)	(1.24e-05)	(1.47e-05)
Employees	0.0157	-0.0358	0.0173	-0.0916**
	(0.0211)	(0.0225)	(0.0292)	(0.0391)
Company age	-0.0137	-0.0666	-0.0592	-0.210
	(0.0639)	(0.0726)	(0.0773)	(0.156)
Loss carry forward	-0.860	-1.055	-0.887	2.578*
as share of the result	(0.581)	(1.021)	(0.779)	(1.371)
Observations	407	393	103	101
R-squared	0.312	0.261	0.463	0.534
Sample	Results over assets between -6% and 18% (25th-75th percentile)	Results over assets between -6% and 18% (25th-75th percentile)	Results over assets between -1.5% and 1.5%	Results over assets between -1.5% and 1.5%

A constant term and time and industry dummies (not reported) are included in all regressions.
The transfer prices and internal leverage are standardized as % of the firm's average total assets over the period.
*** p<0.01, ** p<0.05, * p<0.1

interpret the coefficients as marginal effect in any case. However, the fact that the coefficients increase as we seek to reduce problems related to omitted variables, and the fact that the simultaneity bias probably causes an attenuation bias, at least indicate that our baseline results are not overestimated. Hence, we are confident that MNCs (at least daughter companies) use transfer-pricing strategies in order to shift losses, not only profits. In total, being rather a conservative estimate, the significantly negative coefficient on the loss-position dummy gives support for the ex-post scenario in case of transfer pricing.

Results for total internal leverage are reported in Columns (B) and (D). We observe that even though the coefficients increase substantially, they are still far from being significant at any conventional level of significance. Accordingly , the conclusion is that companies seem to use internal leverage to a lesser extent than transfer pricing when shifting losses. This interpretation is in line with Büttner and Wamser (2013) who suggest that the adjustment costs of the capital structure should be very high. Since the simultaneity bias gives an attenuation bias, we can not conclude that internal leverage is not changed as a response to losses. However, it does seem that transfer pricing is the more flexible tool of the two. Moreover, it suggests that there is at least some support for Hypothesis 3 and ex-ante profit shifting when it comes to debt shifting.

3.4.3 Discussion

Our first empirical finding, based on descriptive statistics and summarized in Figure 3.1, was that affiliates of MNCs indeed bunch more around zero profitability than domestic (stand-alone) firms. This holds also for loss-making affiliates, reporting lower losses than domestic firms. Of course, this finding neither proves that MNCs use profit-shifting strategies to reduce losses nor does it allow to conclude anything about causality. However, the bunching confirms earlier findings in Grubert et al. (1993) and in de Simone and Seidman (2013) who can infer from their approaches that the bunching is related to profit shifting. Hence, it appears to be safe to argue that the plausible arguments in our theory model carry over to reality. The interesting issue, however, is how flexible MNCs are in adjusting their earnings management during the tax year and which of the profit-shifting devices can be used to reduce losses. This is where our regression analyses comes into play.

We find substantial flexibility in transfer pricing, indicated by a highly significant loss-position dummy that indicates an inflow of transfer payments of roughly 6 and 9 percentage points of total assets (for affiliates with returns over assets in [−6%; 18%] and [−1.5%; 1.5%] respectively) if an affiliate reports a negative tax base at the end of the tax year, cf. columns (A) and (C) in table 3.5. Having in mind also the attenuation bias present, this is clear evidence in support of ex-post profit shifting (cf. Hypothesis 2), when it comes to transfer pricing. For internal leverage and debt shifting, the picture is very different. In none of our regressions on internal debt, the loss-position dummy reaches any conventional level of significance, even when we analyse short-term and long-term debt in separation. But, there is again an attenuation bias at work so that we cannot draw any definite conclusion.

Nevertheless, the data clearly indicates that transfer pricing is providing more flexibility to adjust and to revert earnings management. Furthermore, our preferred interpretation of our findings is that there is substantial inflexibility in internal leverage indicating that Hypothesis 3 and some need for ex-ante profit shifting are closer to reality, when talking about debt shifting. A 28 percentage point reduction of the debt tax shield should trigger some significant effect on leverage.[23] Another indicator for this view could be the fact that the expected loss probability, measured via being in a loss position in the previous year, has a negative impact on long-term internal debt on the 10% significance level (cf. column (D) in table 3.4). Accordingly, loss expectations seem to affect the debt-shifting decision at the beginning of the year.

Our preferred interpretation of rather inflexible internal leverage also relates to other studies and to findings on external leverage. When conceding that the tax effects on internal debt shifting are surprisingly low in magnitude, Büttner and Wamser (2013) suggest that the adjustment costs for internal leverage are substantial. Inflexible internal leverage also would have its counterpart in a rigid capital structure of external debt. In the finance literature, it is well known that the target capital structure is only adjusted when the deviations from the optimal leverage are becoming large enough, because adjustments are costly, in particular due to hold-out problems and regulatory issues (e.g., Fischer et al., 1989; Gilson, 1997; Srebulaev, 2007). Korteweg (2010) finds evidence that firms are strategically underleveraged on average, particularly because the costs of overly leverage are significantly higher. We must confess that we cannot explain where the inflexibility in holding internal debt is coming from, because neither enforcement problems to accept an earlier repayment of debt nor regulatory

[23]In our sample period, profitable affiliates in Norway faced a statutory corporate tax rate of 28%. When disclosing losses, the effective tax rate drops to zero.

disincentives should matter for internal debt. One reason could be covenant issues, i.e., contracts with external debt holders, that prevent affiliates from paying back internal loans as such a settlement would reduce the liquidity and the ability to serve external debt. A common incentive to underleverage both in external and in internal debt, however, would be to avoid having leverage when ending up with a negative tax base. Hence, ex-ante profit shifting and anticipating potential year's end losses are a consistent piece of explanation for underleveraging affiliates, even though they are profitable.

Such anticipation also has a major impact on the tax sensitivity of debt shifting and could contribute to finding an explanation for one of the biggest puzzles in the literature on debt shifting. All studies in this area find highly significant, but surprisingly modest/low effects of tax incentives on the use of internal debt. The estimates for the semi-elasticity of internal debt lie between 0.69 and 1.3; for external debt the range is between 0.34 and 0.69.[24] Still, debt shifting is considered to be an important channel to shape earnings disclosures and tax payments (OECD, 2013). Common to all these studies is that they estimate the tax effect by focusing on the statutory tax rate (differential) and that they try to eliminate reversed profit-shifting incentives under losses by dropping all firm-year observations in which affiliates report losses in that year. But, under ex-ante profit shifting and anticipating potential losses when deciding on internal debt at the beginning of the year, this procedure is insufficient and gives rise to an omitted-variable bias, underestimating the tax sensitivities.

Based on our theory model and on equation (3.13a), the explanatory equation for internal leverage should be based on the expected tax rate differential. That is, one should not only capture the maximum tax rate differential, but also correct for the fact that the debt tax shield cannot be utilized with a given probability.[25] Therefore, rearranging equation (3.13a) and applying the specification of debt costs (3.7), internal leverage needs to be explained by

$$b_i = (t_i - t_1)\frac{r}{\eta_b} - H(p_i^0)t_i \cdot \frac{r}{\eta_b} = \gamma_1 \cdot (t_i - t_1) - \gamma_i \cdot H(p_i^0)t_i \tag{3.15}$$

As the two terms are correlated by definition, the coefficient on the tax rate differ-

[24]See, in particular, Desai et al. (2004), Huizinga et al. (2008), Egger et al. (2010), Møen et al. (2011) and Büttner and Wamser (2013). Møen et al. also provide a more extensive discussion of this issue as well as some literature review.

[25]For internal debt shifting, not being able to utilize the debt tax shield in the leveraged affiliate increases total tax payments, actually, because the internal bank still has to pay taxes on interest income received.

ential, γ_1, will pick up the negative impact of anticipating potential losses at year's end if the estimation equation omits the second explanatory variable, i.e., arbitrarily imposes $\gamma_i = 0$ in the regression, as the entire debt-shifting literature to date does. Consequently, neglecting the adjustment for loss anticipation will lead to a potentially severe underestimation of the correct tax-rate sensitivity of internal debt. Note that the unconditioned likelihood of ending up with losses, i.e., the share of observations with losses, within a tax year is 38% in our data set.

Based on these considerations and our finding of substantial flexibility in transfer pricing, it should also be less of a surprise that empirical studies focusing directly on the tax sensitivity of transfer pricing find a high reagibility (e.g., Swenson, 2001; Clausing, 2003; Bartelsman and Beetsma, 2003; and Langli and Saudagaran, 2004). Under the ex-post profit shifting scenario (cf. Hypothesis 2), the anticipation of losses in the tax year to come does not matter for the behavior of affiliates that report positive profits at year's end. Accordingly, the standard procedure to exclude affiliates disclosing negative profits works well for transfer pricing and eliminates the offsetting effects of reverted profit-shifting strategies under losses, indeed. Conventional wisdom to date is that transfer pricing is more attractive because it can shift more profits and costs of concealing profit shifting are lower than for conducting debt shifting. This should be an undisputed matter of fact. But still, our findings suggest that part of the difference in the empirical literature should also be due to the fact that transfer pricing is very flexible whereas the debt-shifting literature suffers from a so far unrecognized negative omitted-variable bias.

3.5 Conclusion

This chapter asked the question whether multinational firms have the opportunity to revert their earnings-management strategies during the tax year. The theory part points out that (in-)flexibility in reverting the profit shifting streams has crucial implications for firm's behavior in achieving a tax-efficient earnings management also under losses. Under full flexibility, firms can adjust their payments ex-post, i.e. at the end of the tax year, to ensure zero taxable profits. Without flexibility, firms have to decide ex ante on their tax avoidance strategies and cannot revisit these decisions once they are taken. According to our empirical estimation, tax avoidance through transfer price manipulation gives firms some leeway to adjust their profit shifting channels ex post. We do not find that firms adjust their financial structure to revert payments.

Importantly, the chapter delivers an explanation for the puzzle, why tax elasticities of internal debt are so low. If firms are inflexible in adjusting their capital structure, i.e. they are forced to decide on their earnings management strategies ex-ante (at the beginning of the tax-year), it is the expected tax rate differential that is decisive and not the statutory tax differential.

While most of the existing empirical work investigates profit shifting of profitable affiliates to low-tax countries, profit shifting to unprofitable high-tax affiliates seems to have escaped the attention of both researchers and policymakers. Alarmingly, the presence of thin capitalization rules and controlled-foreign-corporation (CFC) rules are ineffective policy instruments to correct firm's incentives to revert profit shifting streams as most profits are shifted via transfer price manipulation also to high-tax affiliates. Especially within Europe, where the European Court of Justice has tried to ban CFC rules for affiliates that operate within the European Economic Area and belong to multinationals that are headquartered in a European Economic Area country, the magnitude of profit shifting could me more severe. It is therefore unavoidable for revenue authorities, firstly, to increase the intensity of auditing firms whose profits bunch around zero and, secondly, also to scrutinize transaction to other high-tax affiliates that are in a loss position.

Chapter 4

Cross-border loss offset can fuel tax competition

4.1 Introduction

Since the 2005 *Marks and Spencer* ruling by the European Court of Justice (ECJ), cross-border loss compensation for multinational firms has become an important policy issue in Europe. In this case the ECJ decided that the U.K. based parent company should not be prevented from deducting the losses of its subsidiary in another EU member state, if all loss offset possibilities in the host country of the subsidiary have been exhausted and the losses in the host country are therefore 'final losses'.[1] As a result of this decision, it is likely that EU member states will be legally obliged to offer some form of cross-border tax relief to multinational businesses. This will constitute a major change in current international tax systems, as most EU countries currently permit loss offset only between entities that reside in the same jurisdiction.[2]

In the wake of the *Marks and Spencer* ruling, the European Commission has presented alternative measures for providing a coordinated cross-border loss relief, which differ

This chapter is based on joint work with Andreas Haufler.

[1]Nevertheless the ECJ permitted the U.K. government to deny the parent company of *Marks and Spencer* to deduct the losses incurred by its subsidiaries in Belgium, France and Germany from its positive taxable profits in the United Kingdom, because it did not consider the subsidiaries' losses to be 'final'. See Lang (2006) for a critical discussion of the ECJ's argument and Boulogne and Slavnic (2012) for a review of further court decisions that have clarified the interpretation of 'final losses'.

[2]At present, only four out of 27 EU member states (Austria, Denmark, France and Italy) apply tax schemes that permit a cross-border loss offset. See European Commission (2006).

primarily in whether the loss transfer from the subsidiary to the parent country would be temporary or definitive (see European Commission, 2006). Moreover, a full cross-border loss offset would be a direct implication of introducing a common consolidated corporate tax base (CCCTB) in the EU, which has recently been proposed by the European Commission (2011). The European Commission has also made it very clear that the introduction of cross-border loss compensation will *not* be accompanied by a harmonization of corporate tax rates. Therefore, an important question is whether, and how, the introduction of cross-border loss offset affects the degree of corporate tax competition in Europe.[3]

Despite its immediate policy relevance, the issue of cross-border loss compensation has so far received only very little attention in formal theoretical analyses. In this chapter we contribute to filling this gap. We set up a symmetric two-country framework with two representative multinational enterprises (MNEs), which have their parent company in one of the countries and a subsidiary in the other. Both MNEs endogenously choose the size of a risky investment project. Hence our model captures the positive effects on MNEs' investment incentives, which are regarded as the major economic advantage of cross-border loss compensation (European Commission, 2006). The two governments non-cooperatively choose their tax rates to maximize domestic tax revenues when, following current international practice, the parent and the subsidiary of a MNE are taxed as independent entities. A particular focus of our analysis lies on the question of how the introduction of a coordinated form of cross-border loss offset will affect the governments' non-cooperative tax choices.

In our benchmark scenario, we assume that the parent country of the MNE bases the tax rebate on its own, *home country* tax rate. This corresponds to the current practice in those countries that offer a unilateral cross-border loss offset to resident MNEs (see footnote 2). Moreover, this scheme also underlies the European Commission's proposals for a coordinated cross-border tax relief. We show that when this scheme is applied, an increase in loss offset opportunities is likely to lead to falling tax rates in equilibrium, and hence to intensified tax competition, at least when loss offset is almost complete in equilibrium. The fall in equilibrium tax rates will in turn cause tax

[3]Corporate tax rates have fallen around the world, but the reduction has been particularly strong in Europe. Between 1995 and 2011, statutory corporate tax rates fell from 35% to 23% in the average of the EU-27 countries, and thus substantially more than in the non-EU member states of the OECD (see Eurostat 2011, Tables II-4.1 and II-4.2). Moreover, recent empirical work confirms the existence of strategic interaction in corporate tax setting among OECD countries in general, but in particular among the member states of the European Union (Devereux et al. 2008; Davies and Voget, 2008).

revenue losses for each country to be even larger than is implied by the direct effect of the reform. The reason underlying this result is simple: maintaining a high corporate tax rate becomes more costly under cross-border loss compensation, because it induces a higher tax rebate to the resident MNEs. We conclude that if this scheme is realized, introducing cross-border tax relief may further fuel the ongoing tax competition in Europe.

We then show that these negative side effects of cross-border loss compensation can be avoided under an alternative loss offset scheme where tax rebates are instead based on the tax rate in the subsidiary's *host country*. In contrast to the benchmark scheme, equilibrium tax rates will rise in this case following the reform. This is because an increase in each country's own tax rate is not accompanied by higher tax rebates to loss-making subsidiaries, but more generous loss offset provisions increase the investment of both MNEs, and thus the corporate tax bases of both governments. As a result, tax revenues even increase under this alternative scheme when cross-border loss compensation is enhanced.

We analyze the robustness of our results by considering investments that are partly financed by intra-company loans, alternative government objective functions, an endogenous choice of the investment's success probability by the MNEs, and asymmetries between the competing countries. A particularly relevant setting arises when tax rates differ between countries. In this case the low-tax country would use a higher tax rate for loss rebates than for taxing positive profits in its territory, if the alternative system is applied universally. These redistributive effects can be avoided if each country applies the minimum of the tax rates in the parent and the subsidiary country to the losses incurred by the subsidiaries of its resident MNE. At the same time, this minimum rule is likely to increase tax revenues in both countries, relative to the universal application of loss offset at the parent country's tax rate.

In the related literature, most theoretical and empirical studies have analyzed the effects of incomplete loss compensation in a closed economy setting. Theoretical analyses have focused mostly on the effects on investment and risk-taking decisions over time (e.g. Eeckhoudt et al., 1997; Panteghini, 2001). The empirical literature has estimated the response of investment decisions to tax law asymmetries in a national setting, where positive profits are immediately taxed, whereas the tax value of a loss can only be offset against positive incomes. This asymmetry has long been known to cause important, negative effects on the investment and risk-taking decisions of firms (Altshuler and Auerbach, 1990; Devereux et al., 1994).

In recent years, a few papers have analyzed loss offset in an international setting, but this literature is still very small. Among the empirical studies, Niemann and Treisch (2005) perform a Monte Carlo simulation analysis of the unilateral introduction of cross-border loss compensation in Austria (see footnote 2). Fuest et al. (2007) estimate the tax revenue effects of a switch to a complete cross-border loss offset under the CCCTB and find that, in the EU average, the corporate tax base falls by 20% as a result of this change. Dressler and Overesch (2013) analyze the impact of national loss offset regimes on MNEs' investment decisions and find mixed empirical support for the claim that generous loss offset provisions increase foreign direct investment.

Little is known, however, about how the introduction of cross-border loss offset shapes national corporate tax policies in a setting of international tax competition. Gérard and Weiner (2003, 2006) study this issue in a framework where MNEs are taxed under formulary apportionment, but they do not derive the full equilibrium changes in tax rates that follow from the reform. Closest to this chapter is Kalamov and Runkel (2012), who derive the non-cooperative equilibrium when countries compete over both tax rates and the rate of cross-border loss offset. Their analysis uses a framework where countries base cross-border tax relief on their own tax rates. The authors find that the loss offset parameter is set to zero in the decentralized equilibrium when countries compete for real investment, but at a positive level when they compete to attract profits. The focus of our analysis is different, as we analyze the coordinated introduction of cross-border loss relief in a setting without profit shifting, and compare its effects under alternative loss offset regimes.

This chapter is structured as follows. Section 4.2 introduces the framework for our analysis. Section 4.3 analyzes the effects of cross-border loss offset under the benchmark scheme, where the tax rebate is based on the tax rate in the parent's home country. Section 4.4 carries out the same analysis under the alternative loss offset scheme, where the tax rate of the subsidiary's host country is used for the tax rebate. Section 4.5 numerically compares the effects of loss offset under these two schemes. Section 4.6 analyzes several extensions of our baseline model. Section 4.7 concludes.

4.2 The framework

We consider a simple one-period model of two small countries, labeled 1 and 2. There are two representative MNEs, each with a parent company in one country and with a subsidiary in the other country. We label firm $i \in \{1, 2\}$ by the country in which the parent is located. Capital is perfectly mobile internationally and is supplied to the firms by the international capital market at an exogenous interest rate normalized to one. Finally, we assume in our baseline model that both firms and countries are perfectly symmetric. This excludes redistributive tax revenue effects that arise from tax rate differentials in a setting with cross-border loss compensation. Hence our benchmark model focuses squarely on the efficiency of firms' investment choices and governments' tax policies. Asymmetries between countries will be introduced in Section 4.6.4.

The two MNEs produce a homogeneous good for the world market, at a world price normalized to one. Production occurs with capital and a fixed factor, leading to the production function $f(k_i)$, with $f_k > 0$ and $f_{kk} < 0$. Hence pure profits arise from decreasing returns to scale in production.

Each MNE chooses the level k_i of a risky investment. We assume, for simplicity, that this investment choice is made only by the subsidiary of firm i (which is located in country j). In our baseline model, the investment is successful with an exogenous probability p, and unsuccessful with probability $(1 - p)$.[4] The success probabilities are identical for the two MNEs, but they are uncorrelated and hence the risk of the investment is idiosyncratic. The parent company of each firm has an exogenous profit income equal to $\overline{G}_i$, which is sufficient to cover all possible losses of the subsidiary.[5] The MNEs behave in a risk-neutral way and maximize their net expected payoff.

Corporate income taxes are modeled as proportional taxes on profits. We assume that taxes are imposed by the source country of the investment.[6] This implies that country j taxes the profits of the subsidiary of firm i, whereas the parent country of this firm, i, exempts this income from tax. Moreover, our analysis focuses on the effects that cross-border loss offset introduces under the current principle of *separate accounting*,

[4] In Section 4.6.3 we allow firms to endogenously choose the success probability of the investment.

[5] Alternatively, we could assume that the parent company of each MNE takes the same decisions as the subsidiary. This, however, would reduplicate the decisions taken within each MNE, increasing the complexity of the analysis without adding additional insights.

[6] The source principle of taxation, where the profits of a subsidiary are tax-exempt in the country of the parent firm, is followed by the overwhelming majority of OECD countries. One of the few exceptions is the United States. See Becker and Fuest (2010) for a recent discussion and analysis.

where the parent and the subsidiary of a MNE are taxed as separate entities.[7]

The essential element of our model is the cross-border loss offset within the MNE. In our static model, losses incurred in one country cannot be offset against positive future profits in the same country. Hence the one-period model highlights the role of cross-border loss offset by effectively turning all losses incurred in one country into 'final losses' (see the introduction). Specifically, we postulate that if the investment project of firm i's subsidiary is unsuccessful, then a fraction $0 \leq \alpha \leq 1$ of the losses can be deducted from the exogenous taxable profit income of the parent firm in country i. Our analysis thus focuses on a setting where the losses of a subsidiary can be deducted from positive profits made by the parent company. In practice this is the setting in which cross-border loss offset is most likely to be introduced, because it minimizes the possibility that the MNE can abuse loss offset provisions.[8]

Finally, we focus on the coordinated introduction of cross-border loss offset in both countries. From a policy perspective, this is motivated by the developing legal standards in Europe, which are likely to introduce common rules for cross-border loss relief in the EU member states. From an analytical perspective, no country has an incentive to unilaterally set a positive level of cross-border loss offset in our framework.[9] This corresponds to the empirical observation that only very few countries grant cross-border tax relief unilaterally (see footnote 2).

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[7]In contrast, Gérard and Weiner (2003, 2006) base their analysis of cross-border loss offset on a system of *formulary apportionment*, where the total profits of a MNE are aggregated and then allocated to the various host countries according to a predetermined formula. It is well-known that the tax incentives for national governments can be very different under separate accounting and under formulary apportionment (see e.g. Riedel and Runkel, 2007).

[8]If a parent company's losses can be deducted from the profits of a subsidiary, then the MNE will often have a choice in which country to offset the losses. If the tax rebate is based on the tax rate in the country granting the tax relief, the MNE has an incentive to offset the parent's losses in the host country with the highest tax rate. For this reason, there is considerable skepticism against a 'downward' cross-border tax relief, in contrast to the 'upward' tax relief that we consider here. See European Commission (2006).

[9]This is different in the analysis of Kalamov and Runkel (2012). In their model, two governments unilaterally set their corporate tax rates and their degree of cross-border loss-offset to attract investment and profits from two MNEs. If the two countries only compete via foreign investment, the optimal degree of loss offset is zero (see their Proposition 1). The reason is that the total capital stock is fixed in their model and unilateral cross-border loss offset granted in one country makes it more attractive to invest in the other country, in order to benefit from the tax rebate. If investment levels in each country are fixed, however, and governments compete only over profit shifting, the optimal unilateral degree of loss offset is positive (Proposition 2). The intuition is here that if country i unilaterally introduces cross-border loss offset, this will make it less attractive for the MNE to shift profits to the other country j, because transferring positive profits to j will reduce the expected losses that can be offset against the tax liability in i.

4.3 Benchmark: Loss offset at the home country's tax

In this section, we analyze the implications of cross-border loss-offset under the benchmark scheme where the MNE's home country applies its own tax rate to grant cross-border tax relief to the domestic firm for the losses incurred by its foreign subsidiary. This scheme is currently applied by the countries that offer a unilateral cross-border loss offset and it also underlies the European Commission's proposals for the coordinated introduction of cross-border tax relief.

4.3.1 Firms and governments

Given the corporate tax rates t_i and t_j, the expected after-tax profits of the MNE based in country i are

$$E(\pi_i) = (1 - t_i)\overline{G}_i + (1 - t_j)p[f(k_i) - k_i] - (1 - \alpha t_i)(1 - p)k_i \qquad \forall\, i \neq j. \quad (4.1)$$

The first term in (4.1) describes the exogenous profits of the parent company, net of the tax rate applied in the parent firm's home country i. The second term captures the net profits of firm i's subsidiary in country j in the case where the investment is successful, whereas the third term captures the losses incurred by the subsidiary when the investment fails. Both of these terms depend on the assumptions made about the financing of the subsidiary's investment. We focus here on the simplest possible case where all investment is financed by external debt.[10] In this case, the cost of capital (with the interest rate normalized to one) can be fully deducted from the value of output so that the corporate tax base in the second term corresponds to a pure profit tax, conditional on the investment being successful. If the investment fails, the value of output is zero and the before-tax loss in the third term equals the total capital cost k_i. This loss is reduced by the tax relief granted in the parent's home country i, where the tax credit depends on country i's tax rate and on the internationally coordinated loss offset factor α.

Maximizing (4.1) with respect to k_i implicitly defines the subsidiary's optimal invest-

[10] In Section 6.1 we discuss the implications of allowing for a partial financing of the subsidiary's investment through a loan from its parent company.

ment level by

$$f_{k_i} - 1 - \frac{(1-p)}{p(1-t_j)}\,(1-\alpha t_i) = 0 \qquad \forall\, i \neq j. \tag{4.2}$$

In the absence of uncertainty ($p = 1$), the third term on the left-hand side of (4.2) is zero and the optimal investment level is determined by the usual condition that the marginal product of capital, f_k, equals the exogenous world interest rate of unity. In the presence of uncertainty, but in the absence of taxes, the marginal productivity of capital in case of success must rise by $(1-p)/p$, in order to compensate the risk-neutral investor for the possibility of failure. This decision is distorted by a tax system that taxes positive profits but grants no tax relief for losses incurred. If no cross-border loss offset occurs at all ($\alpha = 0$), the marginal product of capital must rise by $(1-p)/[p(1-t_j)]$. This implies an underinvestment by the subsidiary that is the more severe, the higher is country j's tax rate. Introducing cross-border loss offset counteracts this distortion, but it will only fully eliminate it when the loss offset parameter α equals one and tax rates in both countries are identical.

From (4.2), the effects of taxes on the firm's optimal investment choice k_i are:

$$\frac{\partial k_i}{\partial t_i} = -\frac{\alpha(1-p)}{p(1-t_j)f_{k_i k_i}} \geq 0, \qquad \frac{\partial k_i}{\partial t_j} = \frac{(1-\alpha t_i)(1-p)}{p(1-t_j)^2 f_{k_i k_i}} < 0, \tag{4.3}$$

$$\frac{\partial k_i}{\partial t_i} + \frac{\partial k_i}{\partial t_j} = \frac{[1-\alpha+\alpha(t_j-t_i)](1-p)}{p(1-t_j)^2 f_{k_i k_i}} \leq 0. \tag{4.4}$$

Equation (4.3) shows that an increase in country j's tax rate leads to less capital investment by the subsidiary of firm i.[11] In contrast, by increasing the expected tax rebate, an increase in the tax rate of country i increases capital investment by firm i's subsidiary when the loss offset parameter α is strictly positive. From equation (4.4) we see that when both tax rates are simultaneously increased, the negative effect of t_j on k_i dominates, unless cross-border loss offset is complete and tax rates are identical in the initial equilibrium.

Turning to the two governments, we postulate in our baseline model that they set tax rates to maximize corporate tax revenues. This objective captures the concern about tax revenues that features prominently in both policy debates and court decisions on cross-border loss offset. From a theoretical perspective, the assumption that the profit income of MNEs does not enter the governments' objective function corresponds to a

[11]Recall that the subscript i refers to the headquarter country of MNE i, but the subsidiary's investment occurs in country j. Therefore the well-known negative effect of source-based taxes on investment is given by $\partial k_i/\partial t_j$ in our notation.

setting where the residents of each country invest their capital in perfectly diversified global portfolios.[12] The implications of an extended government objective that also incorporates the profits of home-based MNEs are considered in Section 6.2.

Country i's tax base consists of the exogenous profit income $\overline{G}_i$, less the share α of the losses made by the subsidiary of firm i if its investment fails. To these are added the profits made by the subsidiary of firm j when this firm's investment is successful. Tax revenues in each country are thus given by

$$T_i = t_i\{\overline{G}_i - \alpha(1-p)k_i + p[f(k_j) - k_j]\} \equiv t_i B_i \quad \forall\, i \neq j. \tag{4.5}$$

Maximizing with respect to t_i gives country i's optimal tax rate in implicit form:

$$B_i[\alpha, t_i(\alpha), t_j(\alpha)] + t_i(\alpha)\,\frac{\partial B_i}{\partial t_i}[\alpha, t_i(\alpha), t_j(\alpha)] = 0 \quad \forall\, i, \tag{4.6}$$

where the profit tax base B_i is given in (4.5) and

$$\frac{\partial B_i}{\partial t_i} \equiv \Omega_i = \left[p(f_{k_j} - 1)\,\frac{\partial k_j}{\partial t_i} - \alpha(1-p)\,\frac{\partial k_i}{\partial t_i}\right] < 0 \tag{4.7}$$

collects the sum of effects that an increase in t_i has on country i's tax base via the investment decisions of both representative MNEs. From the firms' investment responses (4.3), these effects are all negative. The optimal tax policy thus follows a straightforward inverse elasticity rule: it rises with the total value of country i's tax base B_i, but falls in the aggregate response of the tax base to a tax increase in country i.

4.3.2 The effects of cross-border loss offset

The core question of our analysis is how a coordinated increase in the loss offset parameter α affects optimal tax rates and equilibrium tax revenues. As is shown in Appendix 1, totally differentiating (4.6) and using the symmetry of countries[13] yields

$$\frac{\mathrm{d}t}{\mathrm{d}\alpha} = \frac{1}{\phi}\left(\frac{\partial B}{\partial \alpha} + t\,\frac{\partial \Omega}{\partial \alpha}\right), \tag{4.8}$$

[12] Empirically, globally diversified portfolios are a plausible scenario when most of the small country's capital is invested through financial intermediaries, such as pension funds or insurance companies.

[13] Since the symmetry assumption is used at this point, we drop country indices in the following when no confusion is possible.

where we show in Appendix D.2 that the multiplier ϕ must be positive.

The first bracketed term in (4.8) gives the change in each country's tax base following an increase in the loss offset parameter α. To sign this effect we derive the impact effects of a change in α on equilibrium investment levels.[14] Implicitly differentiating (4.2) shows that increased cross-border loss compensation raises investment by both subsidiaries:

$$\frac{\partial k}{\partial \alpha} = -\frac{t(1-p)}{(1-t)pf_{kk}} > 0. \tag{4.9}$$

Incorporating the investment responses of both firms, the net change in each country's tax base following an increase in α is then given by

$$\frac{\partial B}{\partial \alpha} = -(1-p)k + \frac{(1-\alpha)(1-p)}{(1-t)}\frac{\partial k}{\partial \alpha}. \tag{4.10}$$

The first term in (4.10) gives the negative, direct effect on each country's tax base that results from the increased tax rebate to the loss-making subsidiary of its resident MNE. The second term captures the indirect effects through the induced change in both MNEs' investment behavior. The expansion of risky activities in firm i's subsidiary reduces country i's expected tax base, because the government of country i participates only in the losses, but not in the profits of this subsidiary. Matters are reversed for the subsidiary of firm j, where country i taxes the increased profits in case of success, but does not share in the losses if the investment fails. As long as loss offset is incomplete ($\alpha < 1$), the latter effect dominates and the second effect in (4.10) is strictly positive.

In general, it is therefore not possible to sign the change in each country's tax base that results from an increase in α. The net effect can be signed, however, when cross-border loss compensation is almost complete and $\alpha \to 1$. In this case, the indirect effects in the second term of (4.10) sum to zero. Intuitively, the symmetry of the model implies that a rise in α leads to equal increases in the investment levels of both firms. From the firms' optimal investment condition, we then get that the expected increase in the tax base from a successful investment of subsidiary j is exactly offset by the higher expected losses incurred by subsidiary i. Finally, country i's tax rate on the positive profits of firm j equals the effective subsidy rate for the losses of firm i, αt_i, when loss

[14] By impact effect we mean the direct effect of the exogenous parameter change, without taking into account the induced changes in governments' tax policies.

offset is complete ($\alpha = 1$). Hence only the negative direct effect in (4.10) remains and

$$\left.\frac{\partial B}{\partial \alpha}\right|_{\alpha \to 1} = -(1-p)k < 0. \tag{4.11}$$

In the following we will refer to this direct effect as the *mechanical effect* of the reform.

Next, we analyze the effect of improved loss offset opportunities on the elasticity of each country's tax base, as given by Ω. To differentiate (4.7) with respect to α, we use (4.2) and (4.9). Further differentiating the tax sensitivities of capital investments in (4.3) with respect to α gives[15]

$$\frac{\partial \Omega}{\partial \alpha} = \frac{-2(1-p)^2}{(1-t)pf_{kk}} \left[\frac{t(1-\alpha t)}{(1-t)^2} - \alpha \right]. \tag{4.12}$$

The sign of (4.12) is ambiguous, in general. On the one hand, a higher loss-offset parameter implies that the sensitivity with which firm j responds to a tax increase in country i is reduced, as this firm will now receive a higher loss offset in its home country. This corresponds to the positive first effect in the squared bracket. On the other hand, a rise in α increases the tax base loss that country i faces from a domestic tax increase due to the higher loss compensation it has to offer the subsidiary of its home-based firm. This is the negative second effect. The latter effect dominates when loss offset is almost complete ($\alpha \to 1$) and the tax rate is not too high initially ($t < 0.5$).[16] The sign of (4.12) is then negative, implying that a rise in t leads to a larger tax base loss when cross-border loss offset is improved. Using this result along with (4.11) in (4.8) gives conditions that are *sufficient* (but not necessary) to ensure that improved cross-border loss offset will reduce equilibrium tax rates in both countries. This is stated in:

Proposition 4.1 *Consider a symmetric Nash equilibrium in tax rates where governments maximize tax revenues and the losses of subsidiaries are rebated at the tax rate of the parent's home country. Then a small increase in cross-border loss offset $d\alpha > 0$ reduces equilibrium tax rates in both countries, if loss offset is almost complete initially ($\alpha \to 1$), and if initial tax rates are not too high ($t \leq 1/2$).*

[15]For analytical simplicity, we treat f_{kk} as a constant from here on, thus ignoring third derivatives of the production function. Our results remain intact, and are even strengthened, when the third derivative is positive. This is true, for example, for a Cobb-Douglas production function. In this case, a further negative term would be added to eq. (4.12), making it more likely that an increase in α reduces the equilibrium tax rate.

[16]The restriction on tax rates is needed because the sensitivity of firm j's investment response rises more steeply in t than the loss compensation for firm i. Therefore, a high level of t tends to increase the positive first effect in (4.12), relative to the second effect.

Proposition 4.1 is confined to a small change in α in the neighborhood of complete loss offset. We can, however, also derive conditions under which a discrete switch from no to full cross-border loss offset (i.e., from $\alpha = 0$ to $\alpha = 1$) lowers the equilibrium tax rates. Using the (implicit) optimal tax rate expression in (4.6), this requires that $B^1 < B^0$ and $-\Omega^1 > -\Omega^0 > 0$, where the superscripts 1 and 0 refer to the equilibrium values with full loss offset and no loss offset, respectively. Comparing first the numerators in the two discrete equilibria, we get from rearranging the definition of B in (4.5):

$$B^1 < B^0 \quad \Longleftrightarrow \quad p\left[\frac{f(k^1) - f(k^0)}{k^1 - k^0} - 1\right] < \frac{(1-p)k^1}{k^1 - k^0}\,. \tag{4.13}$$

On the left-hand side of (4.13) is the expected average return (net of investment costs) of the incremental investment $k^1 - k^0$ that is induced by a switch from zero to full loss offset. On the right-hand side are the expected losses that the government has to compensate under full loss offset, again relative to the induced change in investment. Overall the condition thus states that corporate tax bases will fall when the expected returns to the additional investment are moderate, relative to the additional risks taken by the firms (and shared by the governments).

Turning to the comparison of denominators, substituting (4.2), (4.3) and (4.9) in (4.7) and rearranging gives

$$-\Omega^1 > -\Omega^0 \quad \Longleftrightarrow \quad t^0 < 1 - \sqrt{0.5}. \tag{4.14}$$

Hence, similar to Proposition 4.1, an additional constraint is that tax rates must not be too high in the initial equilibrium without loss offset.

If the conditions (4.13) and (4.14) are simultaneously fulfilled, it follows from (4.6) that $t^1 < t^0$. This is summarized in:

Proposition 4.2 *When losses of subsidiaries are rebated at the tax rate of the parent's home country, a discrete switch from zero to full cross-border loss offset reduces equilibrium tax rates in both countries, if the expected returns to the additional investment are moderate, relative to the risks involved, and if tax rates are not too high initially.*

These results isolate an important and, as yet, little studied effect of coordinated arrangements to increase cross-border tax relief. Given that governments remain free to set profit tax rates non-cooperatively, improving the international tax deductibility of losses may render international tax competition more aggressive, at least when loss offset is nearly complete. The reason is that cross-border loss offset increases the costs of maintaining a high tax rate when each country grants the loss offset based on its own tax rate. This effect is the stronger the higher is the degree of loss offset α.

We now derive the equilibrium change in tax revenues following an increase in α. Writing $T_i = T_i[\alpha, t_i(\alpha), t_j(\alpha)]$ and differentiating with respect to α gives[17]

$$\frac{\mathrm{d}T_i}{\mathrm{d}\alpha} = \frac{\partial T_i}{\partial \alpha} + \frac{\partial T_i}{\partial t_j}\frac{\mathrm{d}t_j}{\mathrm{d}\alpha} \quad \forall \quad i \neq j. \tag{4.15}$$

The first term in (4.15) captures the direct effect of α on the tax base, and hence tax revenues, for constant tax rates t_i. From (4.10) and (4.2) this effect can be expressed as

$$\frac{\partial T_i}{\partial \alpha} = t\left[-(1-p)k + \frac{(1-p)(1-\alpha)}{(1-t)}\frac{\partial k}{\partial \alpha}\right] \quad \forall \quad i. \tag{4.16}$$

The first effect in the squared bracket is again the direct or *mechanical effect* of the reform, which is now valued with country i's tax rate. The second term gives the net change in country i's tax revenues through the behavioral responses of both subsidiaries. In case of success, tax revenues in country i increase with an investment expansion of firm j, but decrease with a higher investment of firm i. The net effect will be positive as long as cross-border loss offset is incomplete. We have already shown, however, that the second effect goes to zero, and the tax base change is unambiguously negative, when $\alpha \to 1$ [see eq. (4.11)].

To obtain the general equilibrium change in tax revenues, it remains to sign the externality that the induced tax change in the other country j has on country i's tax base. From (4.5) we can show that this externality is unambiguously positive and country i's tax base will rise following a tax increase in country j:

$$\frac{\partial T_i}{\partial t_j} = t_i\left[p(f_k - 1)\frac{\partial k_j}{\partial t_j} - \alpha(1-p)\frac{\partial k_i}{\partial t_j}\right] \geq 0 \quad \forall \quad i \neq j. \tag{4.17}$$

The first effect in (4.17) shows that a rise in t_j increases investment by firm j's subsidiary, as this firm will now receive a higher tax rebate in the event of a loss. This effect increases the tax base of country i. Second, a higher tax rate in country j reduces firm i's investment and thus reduces the volume of tax rebates that country i has to grant its resident MNE. Hence both effects work in the same direction and the tax

[17] Note that the effect of country i's own tax rate on its tax revenues T_i is zero from the envelope theorem.

externality is always positive. In the symmetric Nash equilibrium, this implies that both countries set their tax rates at inefficiently low levels under the benchmark loss offset scheme, relative to a situation of joint revenue maximization.

We can now combine eqs. (4.16) and (4.17). Using (4.2) and (4.3) and employing the symmetry condition, we get in a first step

$$\frac{\mathrm{d}T}{\mathrm{d}\alpha} = t\left[-(1-p)k - t\,\frac{(1-\alpha)(1-p)^2}{p(1-t)^2 f_{kk}}\right] - t\,\frac{2\alpha(1-p)^2(1-\alpha t)}{p(1-t)^2 f_{kk}}\frac{\mathrm{d}t}{\mathrm{d}\alpha}.$$

In a second step we substitute t in the squared bracket of the first term and in the second term by $-B/\Omega$ [cf. eq. (4.6)] and use (4.2) and (4.3) again. This yields:

$$\frac{\mathrm{d}T}{\mathrm{d}\alpha} = t\left[-(1-p)k + \frac{(1-\alpha)(1-t)B}{(1-\alpha t)^2+\alpha^2(1-t)^2}\right] + \frac{2\alpha(1-t)(1-\alpha t)B}{(1-\alpha t)^2+\alpha^2(1-t)^2}\frac{\mathrm{d}t}{\mathrm{d}\alpha}, \quad (4.18)$$

where B is each country's tax base, as defined in (4.5). Evaluating (4.18) at $\alpha = 0$ and $\alpha = 1$, respectively, gives:

$$\left.\frac{\mathrm{d}T}{\mathrm{d}\alpha}\right|_{\alpha=0} = tE(\pi^0) > 0, \qquad \left.\frac{\mathrm{d}T}{\mathrm{d}\alpha}\right|_{\alpha\to 1} = -t(1-p)k + B^1\left.\frac{\mathrm{d}t}{\mathrm{d}\alpha}\right|_{\alpha\to 1} < 0, \quad (4.19)$$

where $E(\pi^0)$ is the MNE's after-tax profit [as defined in eq. (4.1)] for $\alpha = 0$ and B^1 is the corporate tax base for $\alpha = 1$. Finally, we have used Proposition 1a to sign $dt/d\alpha$ for $\alpha \to 1$.

Equation (4.19) shows that, starting from an initial value of $\alpha = 0$, an increase in cross-border loss offset raises equilibrium tax revenues. When cross-border loss offset is almost complete, however, tax revenues fall by both the *mechanical effect* and by the decrease in equilibrium tax rates that occurs when the conditions in Proposition 4.1 are fulfilled. Hence a marginal increase in the degree of cross-country tax relief to the point of full loss offset is definitely undesirable for revenue-maximizing governments, as it reduces both the equilibrium tax base and the optimal rate of corporation tax. We summarize our findings in:

Proposition 4.3 *When the losses of subsidiaries are rebated at the tax rate of the parent's home country, then a small increase in cross-border loss offset* $d\alpha > 0$ *lowers equilibrium tax revenues in each country by more than the mechanical effect, if loss offset is almost complete initially* $(\alpha \to 1)$, *and if the initial tax rates are not too high* $(t \leq 1/2)$.

For a *discrete switch* from zero to full cross-border loss offset, tax revenues must unambiguously fall under the conditions summarized in Proposition 1b, as both the tax base and the tax rate are then lower in the equilibrium with $\alpha = 1$, as compared to the case where $\alpha = 0$. Fuest et al. (2007) have isolated the direct tax base effect (mechanical effect) of such a discrete switch and have estimated that this reduces corporate tax revenues in the EU average by roughly 20%. In addition to this direct effect, our analysis incorporates the behavioral responses of both firms and governments. While the investment responses of firms tend to reduce the tax revenue losses borne by governments, their strategic setting of corporate tax rates tends to increase revenue losses when the conditions in Proposition 4.2 are met.

Finally, since countries are symmetric, equation (4.19) also determines the degree of cross-border loss offset that revenue-maximizing governments would jointly set in the first stage of an extended game when they anticipate the non-cooperative setting of tax rates in the second stage. This is given in:

Corollary 1 *Under the benchmark scheme of cross-border loss offset, the optimally coordinated level of α is strictly greater than zero and less than one, when the effects of loss offset on the tax competition between countries are incorporated.*

Corollary 1 can be easily understood from our previous discussion. When α is zero initially, the effect on tax competition is eliminated and an increase in α unambiguously raises investment and tax revenue in both countries. In contrast, when α is close to unity, investment is already at a maximum and the only effect of increasing α further is to make tax competition between countries more aggressive. Hence, if the two symmetric countries coordinate on the level of α while competing over tax rates in a subsequent stage, they will choose an interior level of loss offset $0 < \alpha < 1$.

4.4 An alternative loss offset scheme

4.4.1 Firms and governments

Our analysis in the previous section has shown that introducing cross-border loss offset may intensify tax competition when the MNE's home country bases the tax rebate for the losses of foreign subsidiaries on its own tax rate. This suggests an alternative loss offset scheme, where the home country still grants a tax rebate for the losses of its foreign-based subsidiaries, but applies the tax rate of the subsidiary's *host country* to the loss offset.[18] In the following we analyze this scheme in more detail, focussing again on the issue of how international tax competition is affected by cross-border loss compensation.

With the changed specification of loss compensation, the expected after-tax profits of firm i are given by

$$E(\tilde{\pi}_i) = (1-\tilde{t}_i)\overline{G}_i + (1-\tilde{t}_j)p[f(\tilde{k}_i) - \tilde{k}_i] - (1-\alpha\tilde{t}_j)(1-p)\tilde{k}_i \qquad \forall i \neq j, \quad (4.20)$$

where the tilde indicates terms under the alternative loss offset scheme. The only difference between (4.20) and equation (4.1) in the last section lies in the third term, where losses are now rebated at the tax rate $\tilde{t}_j$ of the subsidiary's host country. The firms' optimal investment decisions are now implicitly determined by

$$f_{k_i} - 1 - \frac{(1-p)}{p(1-\tilde{t}_j)}\,(1-\alpha\tilde{t}_j) = 0 \qquad \forall\, i \neq j. \quad (4.21)$$

Differentiating (4.21) with respect to the tax rates $\tilde{t}_i$ and $\tilde{t}_j$ yields

$$\frac{\partial\tilde{k}_i}{\partial\tilde{t}_i} = 0, \qquad \frac{\partial\tilde{k}_i}{\partial\tilde{t}_j} = \frac{(1-\alpha)(1-p)}{p(1-\tilde{t}_j)^2 f_{kk}} \leq 0 \qquad \forall\, i \neq j. \quad (4.22)$$

Equation (4.22) shows that the tax rate of the parent country no longer has any effects on firm i's choices. This is, of course, partly a result of our simplifying assumption that the investment level of the parent company is fixed. At the same time, the tax rate of the host country j now applies to both positive and negative profits. The net effect of $\tilde{t}_j$ on the investment level of firm i's subsidiary is negative when loss compensation is incomplete. If $\alpha = 1$, the distortion arising from source-based capital taxation disappears and $\tilde{t}_j$ becomes a lump-sum tax.

As before, the objective of both governments is to maximize tax revenues. When country i applies the foreign tax rate $\tilde{t}_j$ to calculate the tax rebate granted to the subsidiary of its home-based MNE, its tax revenues are

$$\tilde{T}_i = \tilde{t}_i\{\overline{G}_i + p[f(\tilde{k}_j) - \tilde{k}_j]\} - \alpha\tilde{t}_j(1-p)\tilde{k}_i \equiv \tilde{t}_i\tilde{B}_i - \alpha\tilde{t}_j(1-p)\tilde{k}_i. \quad (4.23)$$

[18]We thank Clemens Fuest for the suggestion to study this alternative scheme.

Maximizing with respect to $\tilde{t}_i$ gives

$$\tilde{B}_i(\alpha, \tilde{t}_i, \tilde{t}_j) + \tilde{t}_i(\alpha)\, \tilde{\Omega}_i(\alpha, \tilde{t}_i, \tilde{t}_j) = 0, \qquad \tilde{\Omega}_i = p(f_{k_j} - 1)\, \frac{\partial \tilde{k}_j}{\partial \tilde{t}_i} < 0. \tag{4.24}$$

Note from the definition of $\tilde{B}_i$ in (4.23) that the tax rebate to the loss-making subsidiary does not enter the numerator of the optimal tax rate $\tilde{t}_i$ under this loss offset scheme. This has important effects for the countries' incentives to engage in tax competition.

4.4.2 The effects of cross-border loss offset

To analyze the effects of cross-border loss offset, we proceed as in the last section. The effects of α on optimal tax rates correspond to those in eq. (4.8).[19] The impact effect of a change in α on investment is again unambiguously positive under the alternative loss offset scheme. An important difference to the analysis in the previous section is, however, that the loss offset parameter α now affects $\tilde{B}_i$ only through the investment level of firm j. Hence we get:

$$\frac{\partial \tilde{k}}{\partial \alpha} = -\frac{\tilde{t}(1-p)}{(1-\tilde{t})p f_{kk}} > 0, \qquad \frac{\partial \tilde{B}}{\partial \alpha} = \frac{(1-p)(1-\alpha t)}{1-t}\frac{\partial \tilde{k}}{\partial \alpha} > 0. \tag{4.25}$$

The higher loss offset granted by country j increases investment by firm j's subsidiary in country i, thus increasing country i's tax base. At the same time, the higher loss offset increases the loss compensation that country i has to pay its own subsidiary. While this reduces country i's net tax revenues, it does not reduce the tax base, with which country i's tax rate is multiplied [see eq. (4.23)]. Hence, there is no negative *mechanical effect* on the tax rate in this case. In stark contrast to our previous specification [see eq. (4.11)], we thus get the global result that the tax base of each country is unambiguously rising in α under the alternative loss offset scheme.

Turning to the tax base elasticity in (4.24), differentiating with respect to α, using (4.21), (4.22) and (4.25) and simplifying yields:

$$\frac{\partial \tilde{\Omega}}{\partial \alpha} = \frac{-(1-p)^2}{p(1-\tilde{t})^3 f_{kk}}[1 + \tilde{t}(1-2\alpha)] > 0. \tag{4.26}$$

The dominant effect in (4.26) is that firm j's investment will respond less sensitively to a tax increase in country i when the loss offset opportunities in the parent country j are

[19] The level of the multiplier $\tilde{\phi}$ is changed, however. Appendix D.2 shows that $\tilde{\phi} > 0$.

improved. In contrast, the higher loss compensation paid by country i is not relevant for $\tilde{\Omega}$. Noting that $\tilde{\Omega}_i < 0$ from (4.24), the elasticity with which country i's tax base responds to tax changes is thus unambiguously reduced in absolute value when loss offset is improved. Using (4.25) and (4.26) in (4.8), we thus get:

Proposition 4.4 *Consider a symmetric Nash equilibrium in tax rates where governments maximize tax revenues and losses of subsidiaries are rebated at the tax rate of the subsidiary's host country. Then a small increase in cross-border loss offset $d\alpha > 0$ increases equilibrium tax rates in both countries for any initial level of α.*

In contrast to Proposition 4.1 in the previous section, Proposition 4.4 states that country i's optimal tax rate is unambiguously and monotonically rising in α when countries grant cross-border tax relief at the rate of the subsidiary's host country. As a result, it must also be true that a *discrete switch* from zero to full cross-border loss offset unambiguously raises equilibrium tax rates. The core reason for this result is that an increase in the loss offset parameter has no negative direct effect on optimal tax rates in both countries. In other words, while each country still bears the costs of subsidizing the losses of foreign affiliates of domestic MNEs, these costs are no longer affected by the choice of the domestic tax rate. At the same time, the investment expansion of MNEs induced by the rise in α increases tax bases in both countries and thus offers an incentive to increase tax rates.

To compute the equilibrium changes in tax revenues, we follow (4.15) and first consider the direct effect, ignoring for now the tax rate changes induced by enhanced cross-border loss offset. The direct effect on tax revenues is:

$$\frac{\partial \tilde{T}_i}{\partial \alpha} = \tilde{t}\left[-(1-p)\tilde{k} + \frac{(1-p)(1-\alpha)}{(1-\tilde{t})}\frac{\partial \tilde{k}}{\partial \alpha}\right]. \tag{4.27}$$

The structure of (4.27) is analogous to the direct effect in the previous section [eq. (4.16)]. For given tax rates, the *mechanical effect* in the first term has the same negative impact on tax revenues as under the benchmark scheme. The second term is instead positive, as investment in each country rises as a result of improved loss offset.

The tax externality $\partial\tilde{T}_i/\partial\tilde{t}_j$ can be calculated from government i's tax revenues by differentiating (4.23) with respect to $\tilde{t}_j$. This gives:

$$\frac{\partial \tilde{T}_i}{\partial \tilde{t}_j} = \alpha(1-p)\left[-\tilde{t}\,\frac{\partial \tilde{k}_i}{\partial \tilde{t}_j} - \tilde{k}\right]. \tag{4.28}$$

The first effect in this expression is analogous to our analysis in the previous section [see eq. (4.17)]. It is positive as an increase in $\tilde{t}_j$ reduces the investment of firm i's subsidiary, and therefore reduces the expected tax rebate of country i. There is a counteracting second effect, however, which is specific to the tax rebate being based on the tax rate in the subsidiary's host country. By raising its tax rate, the host country j can raise the rate at which country i has to grant tax relief to the subsidiary of its home-based MNE. Taken in isolation, this effect thus provides an incentive for strategic overtaxation under the alternative loss offset scheme.

We can show, however, that the ambiguities in (4.27) and (4.28) both disappear in equilibrium. The total effect of cross-border loss offset on equilibrium tax revenues is given by substituting (4.27) and (4.28) into (4.15). In a first step we employ the symmetry condition and use $\partial\tilde{k}_i/\partial t_j$ from (4.22) and $\partial\tilde{k}/\partial\alpha$ from (4.25). This gives

$$\frac{\partial\tilde{T}}{\partial\alpha} = (1-p)\left[-\tilde{k} - \frac{\tilde{t}(1-p)(1-\alpha)}{(1-\tilde{t})^2 p f_{kk}}\right]\left(\tilde{t} + \alpha\frac{d\tilde{t}}{d\alpha}\right). \tag{4.29}$$

In a second step, we substitute $\tilde{t}$ in the squared bracket by $-\tilde{B}/\tilde{\Omega}$ using (4.24) to get[20]

$$\frac{\mathrm{d}\tilde{T}}{\mathrm{d}\alpha} = \frac{E(\tilde{\pi})}{1-\alpha\tilde{t}}\left(\tilde{t} + \alpha\frac{\mathrm{d}\tilde{t}}{\mathrm{d}\alpha}\right) > 0, \tag{4.30}$$

where $E(\tilde{\pi})$ is the profit of MNEs under the alternative scheme, as defined in (4.20) and $d\tilde{t}/d\alpha$ follows from Proposition 4.4.

Hence, under the alternative scheme, the negative mechanical effect is overcompensated by the increased investment generated by improved loss offset conditions. By the same argument, the negative externality in (4.28) is outweighed by the positive investment effect. Together with the result that tax rates are monotonously rising in α under the alternative loss offset regime from Proposition 4.4, we thus get:

Proposition 4.5 *When the losses of subsidiaries are rebated at the tax rate of the subsidiary's host country, then a small increase in cross-border loss offset $d\alpha > 0$ increases equilibrium tax revenues in each country for any initial level of α.*

Since Proposition 4.5 holds for any initial level of α, we can also conclude that tax revenues will definitely increase for a *discrete switch* from zero to full cross-border loss

[20] Note that eq. (4.30) also holds when $\alpha \to 1$, even though the positive second effect in the squared bracket in (4.29) includes a factor $(1-\alpha)$ in the numerator. The reason is that the tax rate will approach unity when $\alpha \to 1$ so that the factor $(1-\tilde{t})$ in the denominator of this term also approaches zero.

offset. This is in contrast to the benchmark scheme, where the tax revenues effects of cross-border loss offset are negative, at least in the neighborhood of $\alpha = 1$, and the revenue losses exceed the mechanical effect (Proposition 4.3). These differences are primarily driven by the contrasting incentives to adjust optimal tax rates under the two loss offset regimes.

Finally, as tax revenues are monotonously rising in α from (4.30), it is obvious that two symmetric and revenue-maximizing countries would coordinate on the maximum degree of cross-border loss offset under the alternative scheme. This is stated in:

Corollary 2 *Under the alternative scheme, the optimally coordinated level of cross-border loss offset is $\alpha = 1$, when the effects of loss offset on the tax competition between countries are incorporated.*

4.5 Comparing the two loss offset regimes

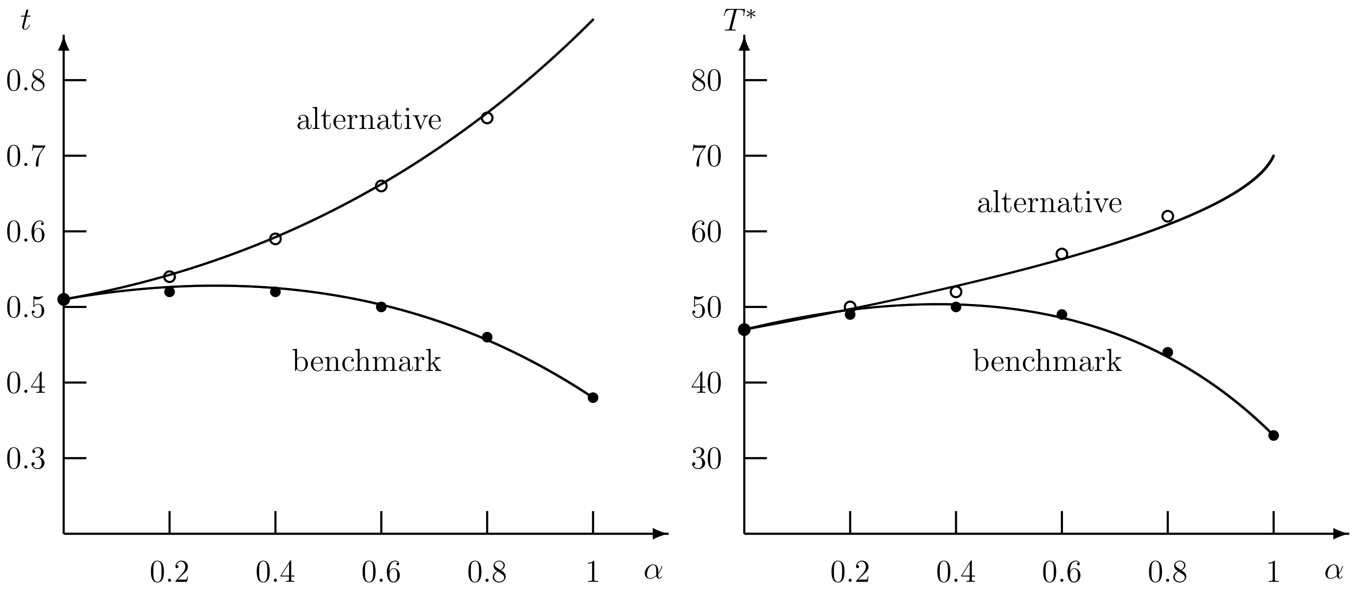
Our theoretical analysis in the previous sections was limited by the fact that results for the benchmark loss offset scheme could only be derived for specific cases. In the following we therefore complement the theoretical analysis with some numerical simulations that compare tax rates and tax revenues under the two loss offset schemes for all possible levels of α. For this purpose we specify the production function of both representative firms as $f(k_i) = Ak_i^{\varepsilon}$, where $\varepsilon < 1$.[21] We present simulation results for two cases, depending on whether the exogenous probability of success is high ($p = 0.8$) or low ($p = 0.5$). The success probability is important because it determines the expected size of the *mechanical effect* under both loss offset systems [see the first terms in (4.16) and (4.27)]. This effect is the larger the lower is the success probability of the investment and hence the larger are the cross-border losses that have to be compensated. The results of our simulations are summarized in Figure 4.1.[22] In the upper half of the figure, Case 1 presents the results for the high success probability $p = 0.8$. In the left panel we compare tax rates for the two loss offset schemes. Under the benchmark scheme, tax rates first rise slightly, as the positive effect of increased investment levels dominates the negative mechanical effect. As α continues to rise,

[21]This production function exhibits a positive third derivative with respect to k, thus ensuring that all propositions for the benchmark scheme in Section 4.3 hold. See footnote 15.

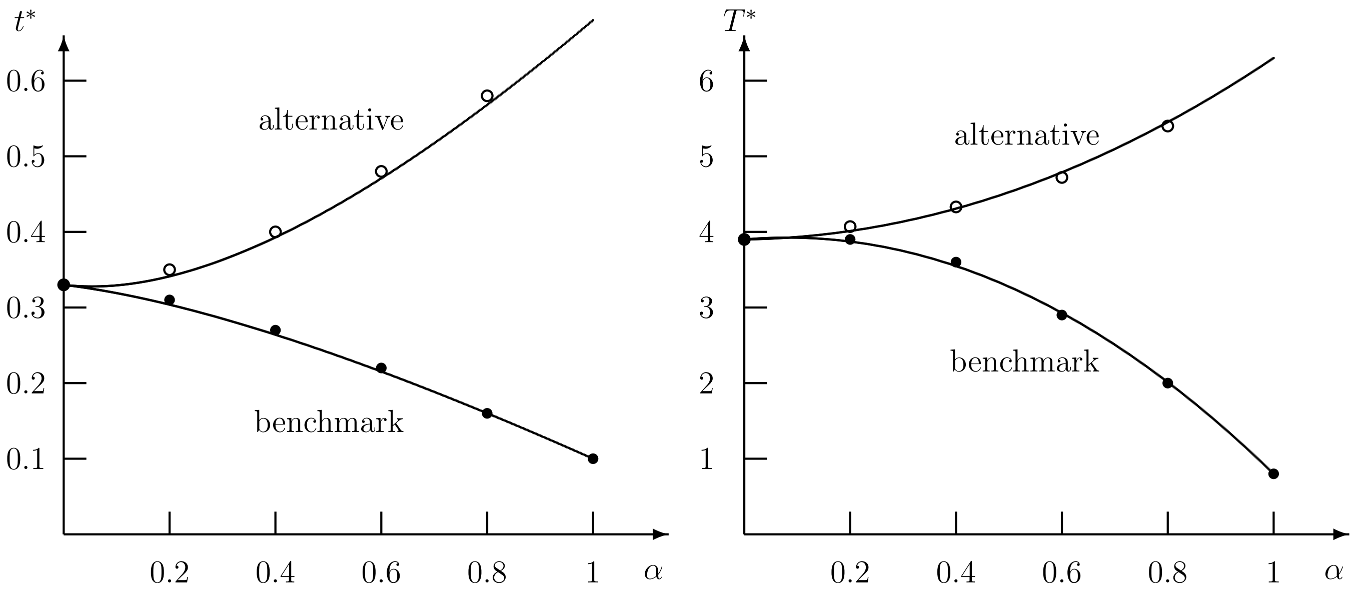
[22]Our simulations confirm that a symmetric equilibrium exists that satisfies the conditions specified in Propositions 4.1 and 4.2. This is true for both regimes, and for all levels of the loss offset parameter α.

Figure 4.1: Tax rate and tax revenue effects of loss offset schemes

Case 1: High success probability ($p = 0.8$)



Case 2: Low success probability ($p = 0.5$)



Notes: $\overline{G} = 0.5,\ A = 5,\ \varepsilon = 0.8$

however, the mechanical effect becomes stronger and tax rates definitely fall, at the margin, as α approaches unity (see Proposition 4.1). Moreover, the figure also shows that the conditions underlying Proposition 4.2 are fulfilled, and a discrete switch from zero to full loss offset lowers equilibrium tax rates. Under the alternative scheme, in contrast, tax rates are monotonously rising in α (see Proposition 4.4) and are above the equilibrium tax rates under the benchmark scheme for any positive level of α.[23]

These differences are mirrored in the tax revenue levels shown in the right upper panel of Figure 4.1. Under the benchmark scheme, tax revenues initially rise, but then fall as α is further increased (Proposition 4.3). Under the alternative scheme, tax revenues are instead monotonously rising in α as higher investment levels overcompensate the mechanical effect (Proposition 4.5). Lastly, and importantly, equilibrium tax revenues under the alternative scheme are always higher than under the benchmark loss offset scheme.

In the lower half of the figure, Case 2 shows the simulation results when the success probability of the investment is relatively low ($p = 0.5$). In this case the mechanical effect is thus stronger than in Case 1. From their common starting point at $\alpha = 0$, tax rates are now monotonously falling under the benchmark loss offset scheme, whereas they monotonously rise under the alternative loss offset scheme. For tax revenues the pattern is qualitatively the same as in the case of a high success probability, but the shortfall of revenues under the benchmark scheme as compared to the alternative scheme is quantitatively more pronounced. Hence the case where relatively high loss offset compensation is paid by governments accentuates the differences between the two loss offset schemes. Overall, our simulations thus indicate that the equilibria attainable under the alternative loss offset scheme are very likely to dominate the equilibria under the benchmark scheme when tax revenue maximization is the objective of governments.

4.6 Discussion and extensions

In this section we extend our analysis in several directions. Section 4.6.1 considers the case where subsidiaries finance (part of) their investment by a loan from their parent company. In Section 4.6.2 we modify the governments' objective function to account for the profits of home-based MNEs. In Section 4.6.3 we allow firms to endogenously

[23]Note that, at $\alpha = 0$, the difference between the two loss offset schemes is inconsequential and the equilibria must therefore coincide at this point.

choose the success probability of their risky investments. Finally, in Section 4.6.4 we introduce asymmetries between countries and compare the two alternative loss offset schemes in a setting where redistributive effects between the two countries are present.

4.6.1 Financing the subsidiary's investment via intra-company loans

In this first extension, we briefly explore the implications of allowing the subsidiary to finance (part of) the investment by a loan from its parent company.[24] If this source of finance is incorporated, and if the subsidiary's investment fails, then the loan to the parent firm will not be repaid and the corresponding share of the losses will effectively be transferred to the parent country. In many cases this will lead to the losses being fully deductible from the profits of the parent firm, thus corresponding to a loss offset parameter of $\alpha = 1$ for the investment share financed by intra-company loans.

It is unlikely, however, that the entire investment can be financed by intra-company debt. We thus consider two different cases for the residual financing. In the first case, a share β^D of the firm's investment will still be financed by external debt and this share therefore remains deductible from the corporate tax base. In the second case, the share β^E of the investment will be financed by equity, which is not tax deductible. In both cases, we assume that the parent company refinances the intra-company loan by external debt. Therefore, the share of internal debt $(1 - \beta^n)$, where $n = \{D, E\}$, is always tax deductible for the MNE as a whole.

Partial external debt finance. With partial external debt finance, the expected after-tax profits of the MNE in country i [cf. eq. (4.1)] become

$$E(\pi_i) = (1-t_i)\overline{G}_i+(1-t_j)p[f(k_i)-k_i]-(1-p)k_i[(1-\alpha t_i)\beta^D+(1-t_i)(1-\beta^D)]. \quad (4.31)$$

In this case, both means of financing the investment in country j are tax-deductible in case of success [second term in (4.31)]. In case of failure, the aggregate effective rate of loss offset is a weighted average of the internationally coordinated rate of cross-border loss offset α (which applies to the share β^D of external debt) and unity (applying to the share $1 - \beta^D$ of internal debt). This is given in the third term of (4.31). Since

[24] We thank the editor, Tom Gresik, for pointing this issue out to us and suggesting its implications.

international loss offset rules remain relevant for the investment share β^D financed by external debt, our results in the previous sections carry over qualitatively to this case, even though their quantitative importance is reduced.

Partial equity finance. With partial equity finance, the expected after-tax profits of the MNE in country i are

$$E(\pi_i) = (1-t_i)\overline{G}_i + (1-t_j)p[f(k_i) - (1-\beta^E)k_i] - (1-p)(1-t_i)(1-\beta^E)k_i - \beta^E k_i. \tag{4.32}$$

An implication of partial equity financing is that only the share of internal debt financing is deductible from the value of output in case of success [second term in (4.32)]. Moreover, since the costs of equity finance are not deductible from the corporate tax base, they will not give rise to taxable losses in country j in case of failure, and therefore cannot be offset against positive profits made in country i. Hence, in case of failure a loss offset occurs only for the costs of internal debt, but this share can be fully offset from the parent's profits [the third term in (4.32)]. In contrast, the costs of equity finance are never tax deductible and therefore have to be borne in full by the MNE (the fourth term). It is then obvious from (4.32) that the internationally coordinated loss offset parameter α is without any effect in this setting. In sum, therefore, we can conclude that our analysis of alternative cross-border loss offset rules applies only when there is at least some degree of external debt financing.

4.6.2 Home ownership of MNEs

We now analyze how the comparison between the benchmark and the alternative loss offset schemes is changed when each government's objective function includes the profits of the resident MNE.[25] We capture this in our model by incorporating the profits of firm i into country i's government objective function with a weight of $\lambda \leq 1$. National welfare in country i then equals the weighted sum of the net-of-tax profits of firm i and country i's tax revenues. We confine our comparison to the determination of optimal tax rates and their responses to the degree of loss offset α.

[25] Recall that the output price of the good produced by the two representative MNEs is fixed in the world market. Consumer surplus is therefore unchanged throughout our analysis.

Benchmark loss offset scheme. For this scheme, we get from the firm's net profit equation (4.1) and tax revenues (4.5):

$$W_i = \lambda E(\pi_i) + T_i = [\lambda + (1-\lambda)t_i]\overline{G}_i - [\lambda + (1-\lambda)\alpha t_i](1-p)k_i + t_i p[f(k_j) - k_j] + \lambda(1-t_j)p[f(k_i) - k_i] \qquad \forall\, i \neq j. \tag{4.33}$$

Maximizing with respect to t_i and using (4.2) and (4.3) implicitly defines country i's optimal tax rate. Using the superscript W to indicate variables under a welfare objective, country i's optimal tax rate is given by

$$B_i^W + t_i^W \Omega_i = 0, \qquad B_i^W = (1-\lambda)[\overline{G}_i - \alpha(1-p)k_i^W] + p[f(k_j^W) - k_j^W], \tag{4.34}$$

where Ω_i is the same as under tax revenue maximization [eq. (4.7)].

The change in tax rates following an increase in the loss offset parameter α, is again given by (4.8).[26] The change in t_i^W is positively related to the change in the numerator B_i^W of country i's tax rate expression in (4.34). Using (4.9), this is given by

$$\frac{\partial B_i^W}{\partial \alpha} = -(1-\lambda)\left[(1-p)k^W - \frac{\alpha(1-p)^2 t^W}{(1-t^W)pf_{kk}}\right] - \frac{(1-p)^2(1-\alpha t^W)t^W}{(1-t^W)^2 pf_{kk}}. \tag{4.35}$$

In (4.35) the negative first effect carries a welfare weight $(1-\lambda)$, because the negative effect on government i's tax revenues is partly compensated by additional profits of its home-based MNE. In the extreme case where the home MNE's profits and tax revenues are taxed equally ($\lambda = 1$), the negative first effect disappears altogether. The second effect gives the increase in tax revenues collected by country i from additional investment carried out by the foreign-based MNE j. As in the baseline scenario, this effect is unambiguously positive.

The effects of a rise in α on Ω_i have already been calculated in (4.12), and have been shown there to be ambiguous. In particular, this effect is positive when α is very low initially. Hence, for low initial levels of α, tax rates will unambiguously rise following an increase in loss offset under the benchmark scheme, when governments weigh tax revenues and the profit income of its resident MNE equally. For higher levels of α, there is again a tendency towards falling tax rates, however, as in the case of revenue-maximizing governments.

[26] The multiplier, denoted by ϕ^W, differs again, however. In Appendix D.2 we show that $\phi^W > 0$.

Alternative loss offset scheme. For the alternative scheme, we get from the firm's profit equation (4.20) and tax revenues (4.23):

$$\tilde{W}_i = \lambda E(\tilde{\pi}_i) + \tilde{T}_i = [\lambda + (1-\lambda)\tilde{t}_i]\overline{G}_i - [\lambda + (1-\lambda)\alpha\tilde{t}_j](1-p)\tilde{k}_i + \tilde{t}_i p[f(\tilde{k}_j) - \tilde{k}_j] + \lambda(1-\tilde{t}_j)p[f(\tilde{k}_i) - \tilde{k}_i] \qquad \forall\, i \neq j.$$

From (4.21) and (4.22), country i's optimal tax rate under the alternative loss offset scheme is implicitly defined by

$$\tilde{B}_i^W + \tilde{t}_i^W \tilde{\Omega}_i = 0, \qquad \tilde{B}_i^W = (1-\lambda)\overline{G}_i + p[f(\tilde{k}_j^W) - \tilde{k}_j^W], \tag{4.36}$$

and $\tilde{\Omega}_i$ is identical to its value in Section 4.4 [eq. (4.24)].

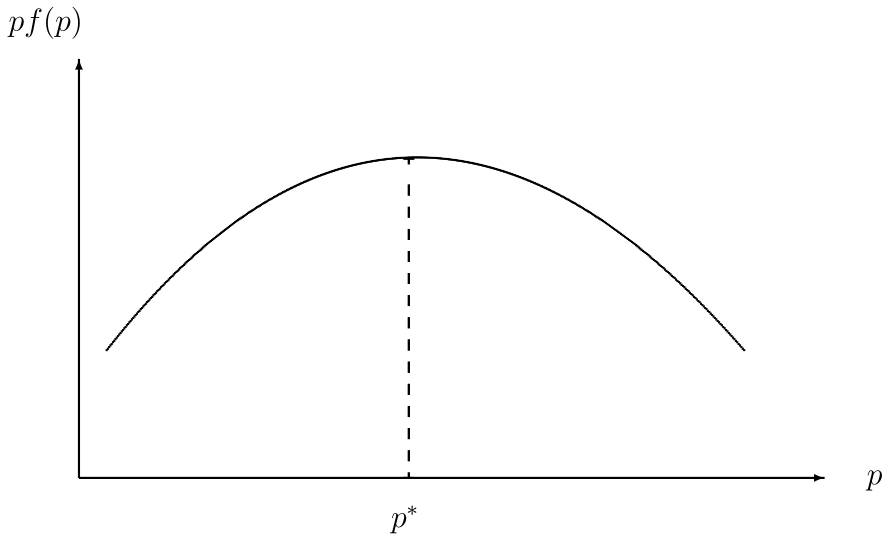
Comparing $\tilde{B}_i^W$ in (4.36) to the corresponding expression under tax revenue maximization [eq. (4.23)] shows that the only difference lies in the constant first term. Together with the unchanged $\tilde{\Omega}_i$, this implies that the effects of changes in α on the optimal tax rate are the same as under tax revenue maximization [see (4.25) and (4.26)] and lead to unambiguously rising tax rates for all initial levels of α. Hence Proposition 4.4 carries over to the case where governments maximize a weighted sum of tax revenues and the resident MNE's net profits.

4.6.3 Endogenous success probability of firms

A further extension of our baseline model is to let the MNEs choose the success probability p_i of their investments. We postulate that, along the technological frontier, there is an infinite number of investment projects that differ in their success probability, where an investment with a lower probability of success delivers a higher return, in case it succeeds.[27] Given our assumption that firms are risk-neutral, each firm thus chooses p_i to maximize its expected after-tax return. The production function is then given by $f(p,k)$ with first-order derivatives $f_k > 0$ and $f_p < 0$ and second-order derivatives $f_{kk} < 0$ and $f_{pp} \leq 0$. Furthermore the failure rate $(1-p_i)$ and the capital investment k_i are assumed to be complements, $f_{kp} < 0$, implying that the higher the probability of success of an investment, the lower is the marginal return on capital.

[27]See Haufler et al. (2014) for an analysis using this model element in a different policy setting.

Figure 4.2: The firm's optimal choice of the project success probability



Benchmark scheme. Under the benchmark loss offset scheme, the first-order condition for the investment level is unchanged from (4.2). The additional first-order condition for the optimal choice of the success probability is

$$f(p_i, k_i) + p_i f_p(p_i, k_i) + \frac{(t_j - \alpha t_i)}{1 - t_j}\, k_i = 0 \qquad \forall\, i \neq j. \tag{4.37}$$

In the absence of taxes, the third term on the left-hand side is zero and the efficient project choice is determined by the condition $f(p_i, k_i) + p_i f_p(p_i, k_i) = 0$. For a risk-neutral investor this first-order condition maximizes the expected return, $pf(p)$, of the project. This is illustrated in Figure 4.2, where p^* is the first-best level of the success probability.

Introducing taxes without a full cross-border loss offset leads to a positive third term on the left-hand side of (4.37) when tax rates are identical. Hence the negative second term must increase, implying a larger value of p_i and hence an inefficiently high success probability. In Figure 4.2 this corresponds to a project choice to the right of the first-best project p^*. Introducing cross-border loss compensation will reduce this distortion, and it will fully eliminate it when $\alpha = 1$ and $t_i = t_j$.

The full analysis of the extended model is complex, and is relegated to Appendix D.3. It is straightforward, however, to summarize the results of this analysis, because the effects of cross-border loss offset on the endogenous success probability are in many ways parallel to those on the investment levels k_i. A higher degree of loss compensation reduces the inefficiently high success probability p_i and thus increases the expected return from the investment. This effect increases the (expected) tax base for both countries. At the same time, the expected tax rebates paid to the home-based MNE rise for both countries, due to the higher probability of failure. In a symmetric equilibrium where loss offset is almost complete ($\alpha \to 1$), these effects will just offset each other and only the negative *mechanical effect* of the reform remains [see eq. (4.11)]. Hence, as in our analysis in Section 4.3, each country will have an incentive to reduce its tax rate following a rise in α, if the level of cross-border loss compensation is already high in the initial equilibrium.

Moreover, each country is again adversely affected by the tax reduction in the other country. In the extended model, the negative effect that a decrease in country j's tax rate has on the tax base of country i is even reinforced through the endogenous choice of a lower success probability. A reduction of t_j makes it more attractive for firm i to choose a lower success probability, and the costs of failure are partly borne by firm i's home country via cross-border loss compensation. Hence the parameter range under which an increase in α reduces tax revenues in both countries is enlarged, relative to the benchmark case.[28] Apart from that, the results from Section 4.3 carry over to this model extension.

Alternative scheme. Under the alternative loss offset scheme, the first-order condition for $\tilde{k}_i$ is given in (4.21). The first-order condition for the optimal $\tilde{p}$ is

$$f(\tilde{p}_i, \tilde{k}_i) + \tilde{p}_i f_p(\tilde{p}_i, \tilde{k}_i) + \frac{\tilde{t}_j(1-\alpha)}{1-\tilde{t}_j}\,\tilde{k}_i = 0 \qquad \forall\, i \neq j. \tag{4.38}$$

The effects of an increase in cross-border loss offset on firms' decisions are analogous to those derived under the benchmark scheme. Hence an increase in α will tend to increase investment and reduce the success probability, both towards their efficient levels. The induced changes in optimal tax rates are analyzed in detail in Appendix D.3. It is shown there that the endogenous choice of $\tilde{p}$ makes it more difficult to unambiguously sign the effects on tax rates and tax revenues for arbitrary levels of α. When the initial level of α is sufficiently large, however, Propositions 4.4 and 4.5 from Section 4.4 can be shown to carry over to this extension and both tax rates and tax revenues rise when α is (further) increased. Moreover, as in the baseline model, each

[28]This is seen from the fact that the restriction on the level of tax rates in Proposition 4.3 is relaxed in this extended setting. See eq. (D.17) in appendix D.3.

country benefits from the tax increase in the other country. In sum, therefore, allowing for an endogenous success probability leads to some changes in the parameter range for which unambiguous results can be derived, but it does not qualitatively affect the results from the baseline model.

4.6.4 Asymmetric countries and a minimum loss offset rule

Our analysis has so far focused on the case of symmetric countries. This is a suitable benchmark case if one wants to find analytical solutions, but the practical implementation of a coordinated cross-border loss offset rule will almost always involve asymmetries between countries. In this more realistic setting analytical solutions for the tax competition game become overly complex. However, the basic effects arising under each of the two alternative loss offset schemes are easily deduced from the incentives for firms and governments derived in Sections 4.3.1 and 4.4.1, respectively.

A simple way to generate differences in equilibrium tax rates in the model is to vary only the exogenous profit levels $\overline{G}_i$ earned by the parent companies in the two countries. Let country 1's parent firm have the lower level of exogenous profit income so that $\overline{G}_1 < \overline{G}_2$ while keeping the production function for the subsidiaries equal across countries. In this setting country 2 will have the higher equilibrium tax rate. Under the benchmark loss offset scheme, this implies that country 1 imposes a lower tax on the subsidiary of firm 2, but simultaneously grants a lower rate of loss offset to the subsidiary of its resident firm 1. Under the alternative loss offset scheme, in contrast, country 1 has to offer a higher rate of tax relief to the subsidiary of its resident company 1 than it applies to the positive profits of the subsidiary of the foreign-based firm 2. In this sense, the alternative loss offset scheme implies redistributive losses for the low-tax country.

To reduce or even eliminate such redistributive effects, it is suggestive to employ a *minimum rule* under which each country grants a tax rebate that is based on the minimum of the tax rates in the parent and the subsidiary country.[29] A minimum rule thus leads to a mixed system of cross-border tax relief where low-tax countries apply the benchmark scheme, whereas high-tax countries use the alternative scheme.

The basic incentive for the low-tax country 1 to limit the rate of loss offset under the alternative loss offset scheme is easily shown by introducing a separate loss offset

[29]This is similar to the worldwide regime for dividend taxation under the tax credit method where the parent country grants a credit for taxes paid in the subsidiary country, but it does not make positive payments to the firm if the tax rate in the subsidiary country exceeds the tax rate in the parent country. See e.g. Gresik (2001, Sec. 5).

rate t_1^{LO}, which applies only to the compensation of losses for the resident firm. The expected profits for firm 1 are then

$$E(\pi_1) = (1 - t_1)\overline{G}_1 + (1 - t_2)p[f(k_1) - k_1] - (1 - \alpha t_1^{LO})(1 - p)k_1.$$

From firm 1's first-order condition, its optimal investment (in country 2) is unambiguously rising in the isolated loss offset rate t_1^{LO}:

$$\frac{\partial k_1}{\partial t_1^{LO}} = \frac{\alpha(1 - p)}{-(1 - t_2)pf_{k_1 k_1}} \geq 0. \tag{4.39}$$

The tax revenue expression for the low-tax country is

$$T_1 = t_1 \left\{\overline{G}_1 + p[f(k_2) - k_2]\right\} - \alpha t_1^{LO}(1 - p)k_1.$$

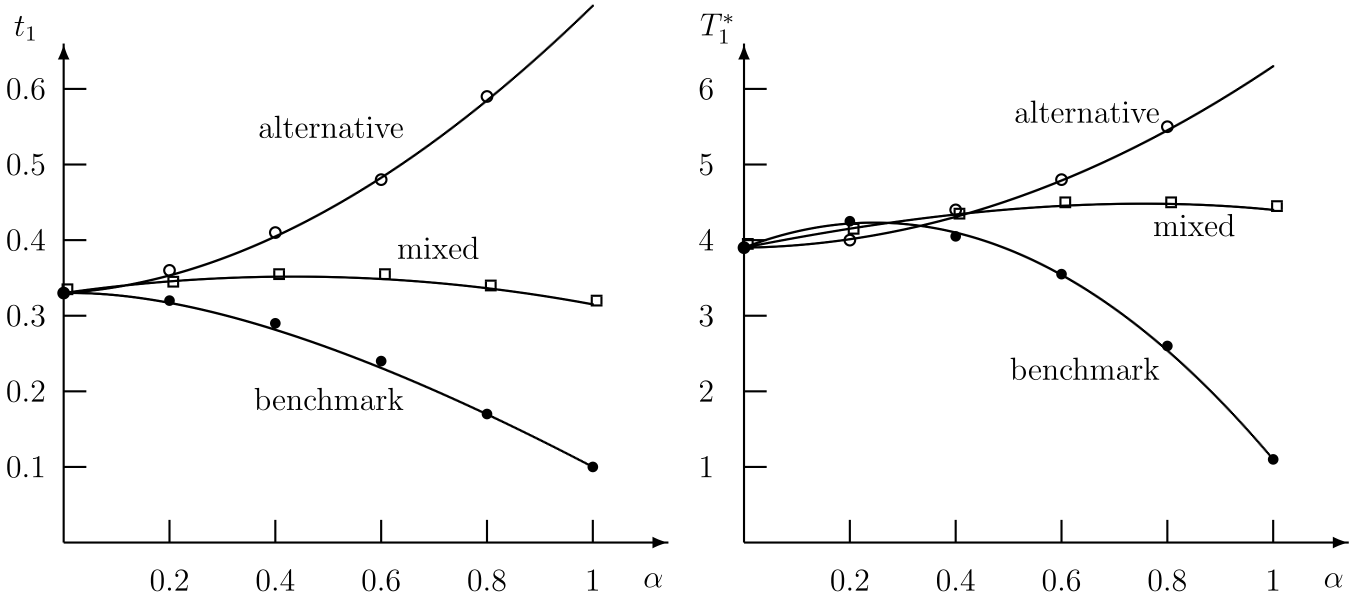
Differentiating with respect to t_1^{LO} gives

$$\frac{\partial T_1}{\partial t_1^{LO}} = -(1 - p)\left[k_1 + \alpha t_1^{LO}\frac{\partial k_1}{\partial t_1^{LO}}\right] < 0, \tag{4.40}$$

which can be unambiguously signed from (4.39). Hence, reducing the tax rate for loss offset t_1^{LO} raises country 1's tax revenues from both the direct (mechanical) effect, and from the reduced investment of its resident firm in country 2. Note, however, that eq. (4.40) captures only the first-round effect of a reduction in t_1^{LO} on country 1's tax revenue. It does not incorporate the general equilibrium effects that arise from the changed nature of tax competition with country 2. These effects must therefore be simulated when countries are asymmetric. Figure 4.3 presents the results from some representative simulations of the tax competition game under the two 'pure' systems of cross-border loss offset and under the mixed scheme just discussed. The exogenous profit levels of parent companies are set at $G_1 = 0.5$ and $G_2 = 5.0$. All other parameters are kept unchanged from the symmetric case shown in Figure 4.1. To emphasize the redistributive effects arising under the alternative loss offset scheme, we assume that the success probability of investments is low ($p = 0.5$) and loss compensation is accordingly likely. Our presentation of the results focuses on the low-tax country 1. The full set of simulation results is reported in Appendix D.4.

The left panel of Figure 4.3 shows how country 1's optimal tax rate develops for changing levels of α. Under the benchmark loss offset scheme, country 1's tax rate again falls monotonically, as in the symmetric case (Case 2 of Figure 1). Under the

Figure 4.3: Tax rates and tax revenue effects for a low-tax country (country 1)



Notes: $\overline{G}_1 = 0.5$, $\overline{G}_2 = 5.0$, $A = 5$, $\varepsilon = 0.8$, $p = 0.5$.

alternative loss offset system, country 1's optimal tax rate is fundamentally unchanged from the symmetric case and is monotonously rising in α. Under the mixed system, where the low-tax country 1 applies the benchmark scheme but the high-tax country 2 applies the alternative scheme, country 1's tax rate lies in between the tax rates of the two 'pure' schemes. In comparison to the case where both countries operate the alternative loss offset scheme, country 1's tax rate is reduced by the switch to the benchmark system, due to the incentive to strategically lower the domestic tax rate. In comparison to the case where both countries use the benchmark scheme, country 1's tax rate is instead increased, because country 2 operates the alternative loss offset scheme and its tax rate is rising in α. The higher tax rate of country 2 lowers investments by the subsidiary of firm 1, which reduces loss compensation for the government of country 1 and allows it to raise its optimal tax rate in equilibrium.

The right panel of Figure 4.3 shows the tax revenue implications for country 1. For low levels of α, tax revenue in country 1 is higher under the benchmark loss offset scheme than under the alternative scheme. In this range, the dominant effect is that country 1 does not have to base its tax rebates on the higher tax rate in country 2 when it uses the benchmark scheme. As α is further increased, however, the higher tax rates chosen under the alternative loss offset scheme overcompensate this effect and tax revenues for country 1 are thus higher under the alternative loss offset scheme.

The mixed scheme yields higher revenues for the low-tax country 1, in comparison to the pure benchmark scheme, once α rises above a certain (low) threshold. This is because country 2 operates the alternative scheme in this case, and will set higher tax rates than if it followed the benchmark scheme as well. As mentioned above, this higher tax rate of country 2 allows the government of country 1 to also increase its tax rate. In comparison to the pure alternative scheme, the mixed scheme has an advantage for country 1 for low levels of α, because country 1 does not have to base its tax rebates on the higher tax rate of country 2. This is the reason why country 1's tax revenues under the mixed system surpass the revenues under the benchmark system at a lower level of α than is true under the pure alternative system.

For the high-tax country 2, the ranking of the three loss offset schemes is instead unambiguous. This country's tax revenues are highest under the pure alternative scheme and lowest under the pure benchmark scheme for all levels of α (see Appendix D.4). In sum, then, there is a trade-off between the mixed loss offset scheme and the pure alternative scheme for the low-tax country, as the mixed scheme reduces negative redistributive effects but also maintains some incentive for downward tax competition. The pure benchmark scheme, in contrast, will be dominated by the mixed scheme unless the level of cross-border loss offset remains sufficiently low.

4.7 Conclusions

In its 2005 *Marks and Spencer* ruling, the European Court of Justice has established the principle that the parent country of a MNE must allow cross-border tax relief for the losses incurred by a subsidiary in a different EU member state, if the losses incurred by the subsidiary are 'final'. Given this ruling, it is very likely that EU member states will be legally obliged to offer some form of cross-border loss offset in the coming years, even though the exact conditions under which this occurs are not yet clear. The critical question is then how to introduce cross-border loss offset in a way that minimizes the negative side effects of this change for member states' tax revenues.

In this chapter we have analyzed two alternative schemes of introducing a coordinated form of cross-border loss offset. Under the first, 'benchmark' scheme, each country bases the tax rebate to loss-making subsidiaries of its domestic MNEs on its own corporate tax rate. When this scheme is applied, a coordinated increase in cross-border loss compensation is likely to reduce optimal tax rates, at least when the level of cross-border tax relief is high. In an environment where tax competition is an important concern, as is the case in Europe, our analysis therefore warns that introducing cross-border loss compensation may well aggravate tax competition, by increasing the 'costs' to governments of applying a high corporate tax rate. These behavioral effects imply that the overall tax revenue losses accompanying the introduction of cross-border tax relief are likely to be even larger than the direct (mechanical) effects of the reform.

We also show that a simple change in the scheme of cross-border tax relief will suffice to eliminate these undesirable side effects of the reform. All that is needed is to apply the tax rate of the subsidiary's host country, rather than the parent country's home tax rate, when calculating the tax rebate. This scheme will also exhibit the efficiency-enhancing effects on firms' investment decisions that represent the core advantages of cross-border loss compensation. In contrast to the benchmark scheme, equilibrium taxes and tax revenues are likely to rise under the alternative loss offset scheme when cross-border loss compensation is increased. Finally, the redistributive effects that arise under this scheme when tax rates differ between countries can be reduced or even avoided, if each country is given the option to apply the minimum of the tax rates in the parent and the subsidiary country to the cross-border loss relief.

Our analysis can be extended in several ways. A first extension would be to introduce an intertemporal model of investment and cross-border loss compensation. This would allow, for example, to distinguish between a temporary and a permanent transfer of losses from the subsidiary to the parent country, or to capture loss carryforward provisions in the host country that are limited in time. We doubt, however, that adding these realistic features would overturn the qualitative conclusions of our analysis with respect to the ranking of the different loss offset regimes. A second, and more fundamental, extension would be to endogenize the location decisions of MNEs, which have been taken as given in the present analysis. In such a setting, countries may have an incentive to grant positive levels of cross-border loss offset in a fully decentralized tax equilibrium, in order to attract headquarter location. An analysis of this case is left for future research.

Conclusion

The process of economic integration has led to increased competition among countries for multinational enterprises. These firms have developed sophisticated strategies in order to shift profits to low tax-countries by eroding their tax bases in high-tax countries. As a consequence, governments' budget, and therefore their provision of public goods and services to their citizens, is adversely affected by firms' tax avoidance strategies. Two decades ago, this threat induced the OECD in its report in the year 1998 to call for more tax cooperation to tackle the arising issue of harmful tax competition practices among its member states and of tax havens. However, the heterogeneity of the member states made it virtually impossible to align all the countries with common source based tax policies. In recent years therefore the focus shifted from coordination to unilateral measures which directly address profit shifting. Among other things, the OECD (2013) report mentions two approaches to combat tax avoidance and profit shifting. First, the extension of residence based taxation, e.g. CFC rules, and second the extension of source based taxation, e.g. thin capitalization rules.

In this doctoral thesis I have analyzed in each of the four chapters a certain aspect of the taxation of multinational corporations. Chapter 1 and Chapter 2 are optimal tax models. Chapters 1 analyzes the above mentioned extension of residence based and source based taxation to counter profit shifting incentives and how they interact. It contributes to explain why some countries have implemented a CFC rule on top of thin capitalization rules while others do not. Chapter 2 focuses on source based taxation, however, in a setting of imperfect capital markets. This chapter reveals that differences in financial development is one reason why a cooperation in source based taxation might fail. Typically, credit market distortions are rather difficult to tackle directly. But they might be addressed by leniency in the thin capitalization rule at least in the short run. Importantly, this incentive is irrespective of any argument of competition for a mobile tax base. Chapter 3 and Chapter 4 differ in the sense that corporate losses are the center point of the analysis. Chapter 3 theoretically and empirically investigates behavioral responses of multinational firms once affiliates are likely to run losses and finds that the manipulation of transfer prices gives firms the highest degree of flexibility to revert their profit shifting streams. For tax authorities, there are three important pieces of information. Firstly, they should intensify audits of firms whose profits bunch around zero. Secondly, profit shifting via internal loans is likely to be more intense than recent empirical studies suggest. Thirdly, it would be unwise to neglect transactions to other high-tax affiliates once these are running a loss. Chapter 4 departs from profit shifting and focuses solely on capital mobility. Therein, I consider a tax competition model where governments participate in firms losses via cross-border loss offset provisions. This chapter delivers some very useful insights for policymakers. Depending on the loss offset scheme tax competition is either likely to be intensified or mitigated. It shows that what policymakers intend to do is not what should be done.

Apart from the extension of residence based and source based taxation, there are two further approaches to combat tax avoidance and profit shifting which I do not address in this thesis.[1] First, a reform of reporting and transparency rules regarding taxes paid by multinational corporations which requires multinationals to publicly disclose data on their financial performance. However, this concept opens another channel for competition if reporting standards are not universally defined. A second approach is a reform of the current system of corporate income taxation by introducing a system of formula apportionment. This concept would make transfer prices obsolete and avoids the problem of measuring transfer prices. Clearly, a world wide concept is utopian. However, as pointed out in Chapter 4, it is likely that the EU will implement some sort of cross-border loss compensation which would be a direct implication of introducing a common consolidated corporate tax base as proposed by the European Commission (2001) at least in the EU. Obviously, this reform option can only tackle profit shifting in the long run. But it might still be beneficial even though multinational corporations could still engage in profit shifting out of the EU (see Riedel and Runkel, 2007). These benefits might even get stronger if corporate losses are taken into account. Under the current system of separate accounting, the possibility of corporate losses reduces the expected tax base of countries, so that they see themselves confronted with a higher tax elasticity. This gives countries rise to cut their taxes. Under a system of formula apportionment, this incentive could be reverted since the corporate income of a multinational company is consolidated and allocated also to governments whose

[1]See Fuest et al. (2013) for a summary of options for reform.

tax base would be zero under a system of separate accounting.

Appendices

A Appendix to Chapter 1

We first totally differentiate the first-order conditions (1.15a) and (1.17a). This leads to the following equation set

$$\begin{bmatrix}\chi_1 & \chi_2\\ \chi_3 & \chi_4\end{bmatrix} \times \begin{bmatrix}\mathrm{d}\lambda_h\\ \mathrm{d}\tau^h\end{bmatrix} = -\begin{bmatrix}\chi_5\\ \chi_6\end{bmatrix}\mathrm{d}\phi \tag{A.1}$$

where

$$\begin{aligned}\chi_1 &= \frac{\partial^2 W^h}{\partial(\lambda_h)^2}, \qquad \chi_2 = \frac{\partial^2 W^h}{\partial\lambda_h\partial\tau^h}, \qquad \chi_3 = \frac{\partial^2 W^h}{\partial\tau^h\partial\lambda_h},\\ \chi_4 &= \frac{\partial^2 W^h}{\partial(\tau^h)^2}, \qquad \chi_5 = \frac{\partial^2 W^h}{\partial\lambda_h\partial\phi}, \qquad \chi_6 = \frac{\partial^2 W^h}{\partial\tau^h\partial\phi}.\end{aligned} \tag{A.2}$$

Applying Cramer's rule to the equation system (A.1), shows the effects of a change in the homebias parameter ϕ on the thin capitalization rule λ_h and the CFC rule τ^h in equilibrium:

$$\frac{\mathrm{d}\lambda_h}{\mathrm{d}\phi} = \frac{\chi_2\chi_6 - \chi_4\chi_5}{\chi_1\chi_4 - \chi_2\chi_3}, \qquad \frac{\mathrm{d}\tau^h}{\mathrm{d}\phi} = \frac{\chi_3\chi_5 - \chi_1\chi_6}{\chi_1\chi_4 - \chi_2\chi_3}, \tag{A.3}$$

where $\chi_1\chi_4 - \chi_2\chi_3 > 0$ to obtain a local maximum and

$$\begin{aligned}\chi_1 &= t_h\left[\phi^2 f''(\phi k_h^h)\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\lambda_h} - r\right]\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\lambda_h} + t_h\left[f''(k_h^f)\frac{\partial k_h^f}{\partial\rho_h^f}\frac{\partial\rho_h^f}{\partial\lambda_h} - r\right]\frac{\partial k_h^f}{\partial\rho_h^f}\frac{\partial\rho_h^f}{\partial\lambda_h}\\ &- t_h r\left[\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\lambda_h} + \frac{\partial k_h^f}{\partial\rho_h^f}\frac{\partial\rho_h^f}{\partial\lambda_h}\right] - \gamma\frac{\partial k_h^h}{\partial\rho_h^h}\left(\frac{\partial\rho_h^h}{\partial\lambda_h}\right)^2\end{aligned} \tag{A.4}$$

$$\begin{aligned}\chi_2 &= t_h r\left[\phi f'(\phi k_h^h) - (\lambda_h + \beta_h^h)r\right]\frac{\partial k_h^h}{\partial\rho_h^h} + t_h\left[\phi^2 f''(\phi k_h^h)\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\tau^h} + \frac{r^2}{\delta}\right]\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\lambda_h}\\ &- t_h r\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\tau^h} - \gamma\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\tau^h}\frac{\partial\rho_h^h}{\partial\lambda_h} - \gamma k_h^h r\end{aligned} \tag{A.5}$$

$$\begin{aligned}\chi_3 &= t_h\frac{r^2}{\delta}\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\lambda_h} + t_h r\left[\phi f'(\phi k_h^h) - (\lambda_h + \beta_h^h)r\right]\frac{\partial k_h^h}{\partial\rho_h^h}\\ &+ t_h\left[\phi^2 f''(\phi k_h^h)\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\lambda_h} - r\right]\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\tau^h} - \gamma r\left[k_h^h + (\lambda_h + \beta_h^h)\frac{\partial k_h^h}{\partial\rho_h^h}\frac{\partial\rho_h^h}{\partial\lambda_h}\right]\end{aligned} \tag{A.6}$$

$$\begin{aligned}\chi_4 &= t_h \frac{r^2}{\delta} \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \tau^h} - t_h \frac{r^2}{\delta} \left[\phi f'(\phi k_h^h) - (\lambda_h + \beta_h^h) r \right] \frac{\partial k_h^h}{\partial \rho_h^h} \\ &+ t_h \left[\phi^2 f''(\phi k_h^h) \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \tau^h} + \frac{r^2}{\delta} \right] \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \tau^h} \\ &- \gamma r \left[(\lambda_h + \beta_h^h) \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \tau^h} + (\lambda_f + \beta_f^h) \frac{\partial k_f^h}{\partial \rho_f^h} \frac{\partial \rho_f^h}{\partial \tau^h} - k_h^h \frac{r}{\delta} - k_f^h \frac{r}{\delta} \right] \qquad \text{(A.7)}\end{aligned}$$

Using (1.5), (1.6), (1.8a), (1.8b), (1.9) and (1.10) we get

$$\begin{aligned}\chi_1 &= t_h r^2 (t_h - \tau^h) \left[1 + \frac{1-\tau^h}{1-t_h} \right] \frac{\partial k_h^h}{\partial \rho_h^h} + t_h r^2 (t_h - \tau^f) \left[1 + \frac{1-\tau^f}{1-t_h} \right] \frac{\partial k_h^f}{\partial \rho_h^f} \\ &- \gamma r^2 (t_h - \tau^h)^2 \frac{\partial k_h^h}{\partial \rho_h^h} < 0, \qquad \text{(A.8)}\end{aligned}$$

$$\begin{aligned}\chi_2 &= \frac{t_h}{1-t_h} r^2 \left[1 - 2(1-\tau^h)\lambda_h - \frac{r}{2\delta}(t_h - \tau^h)[1 + 3(1-t_h) + 3(1-\tau^h)] \right] \frac{\partial k_h^h}{\partial \rho_h^h} \\ &- \gamma r \left[k_h^h - (t_h - \tau^h)(\lambda_h + \beta_h^h) r \frac{\partial k_h^h}{\partial \rho_h^h} \right], \qquad \text{(A.9)}\end{aligned}$$

$$\begin{aligned}\chi_3 &= \frac{t_h}{1-t_h} r^2 \left[1 - 2(1-\tau^h)\lambda_h - \frac{r}{2\delta}(t_h - \tau^h)[1 + 3(1-t_h) + 3(1-\tau^h)] \right] \frac{\partial k_h^h}{\partial \rho_h^h} \\ &- \gamma r \left[k_h^h - (t_h - \tau^h)(\lambda_h + \beta_h^h) r \frac{\partial k_h^h}{\partial \rho_h^h} \right], \qquad \text{(A.10)}\end{aligned}$$

$$\begin{aligned}\chi_4 &= -\frac{t_h}{1-t_h} \frac{r^3}{\delta} \left[1 - 2(1-\tau^h)(\lambda_h + \beta_h^h) - (1-t_h)\beta_h^h + \frac{\delta}{2} \left(\beta_h^h \right)^2 \right] \frac{\partial k_h^h}{\partial \rho_h^h} \\ &+ \frac{t_h}{1-t_h} r^2 \lambda_h (\lambda_h + \beta_h^h) \frac{\partial k_h^h}{\partial \rho_h^h} - t_h \frac{r^3}{\delta} \lambda_h \frac{\partial k_h^h}{\partial \rho_h^h} \\ &- \gamma r \left[(\lambda_h + \beta_h^h) \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \tau^h} + (\lambda_f + \beta_f^h) \frac{\partial k_f^h}{\partial \rho_f^h} \frac{\partial \rho_f^h}{\partial \tau^h} - k_h^h \frac{r}{\delta} - k_f^h \frac{r}{\delta} \right] < 0. \qquad \text{(A.11)}\end{aligned}$$

In general, the sign of χ_2 and χ_3 is ambiguous. However, if δ is small, the third term of the first squared brackets in (A.9) and (A.10) gets large and the overall effect is likely to become positive.

The effects of a change in the home bias on the first-order conditions for the optimal thin capitalization rule and the optimal CFC rule are respectively given by

$$\begin{aligned}
\chi_5 &= t_h \left[f'(\phi k_h^h) + \phi k_h^h f''(\phi k_h^h) + \phi^2 f''(\phi k_h^h) \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi} \right] \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \lambda_h} \\
&+ t_h \left[\phi f'(\phi k_h^h) - (\lambda_h + \beta_h^h) r \right] \frac{\partial \rho_h^h}{\partial \lambda_h} \frac{\partial k_h^h}{\partial \rho_h^h \partial \phi} \\
&- t_h r \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi} - \gamma \frac{\partial \rho_h^h}{\partial \lambda_h} \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi}. \qquad \text{(A.12)}
\end{aligned}$$

$$\begin{aligned}
\chi_6 &= t_h \frac{r^2}{\delta} \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi} + t_h \left[f'(\phi k_h^h) + \phi k_h^h f''(\phi k_h^h) + \phi^2 f''(\phi k_h^h) \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi} \right] \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial \rho_h^h}{\partial \tau^h} + \\
&+ t_h \left[\phi f'(\phi k_h^h) - (\lambda_h + \beta_h^h) r \right] \frac{\partial \rho_h^h}{\partial \tau^h} \frac{\partial k_h^h}{\partial \rho_h^h \partial \phi} - \gamma (\lambda_h + \beta_h^h) r \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi}. \qquad \text{(A.13)}
\end{aligned}$$

$$\frac{\mathrm{d}k_h^h}{\mathrm{d}\phi} = - \frac{f'(\phi k_h^h) + \phi k_h^h f''(\phi k_h^h)}{\phi^2 f''(\phi k_h^h)}. \qquad \text{(A.14)}$$

Generally, the sign of $\frac{\mathrm{d}k_h^h}{\mathrm{d}\phi}$ is ambiguous. However, it is reasonable to assume that capital investment increases if the affiliate gets more efficient.[1] The change in the sensitivity of capital with respect to the effective capital cost is given by

$$\frac{\partial k_h^h}{\partial \rho_h^h \partial \phi} = - \frac{(1 - t_h)[2\phi f''(\phi k_h^h) + \phi^2 k_h^h f'''(\phi k_h^h)]}{[(1 - t_h)\phi^2 f''(\phi k_h^h)]^2}. \qquad \text{(A.15)}$$

Assuming that $f''' = 0$ and using (1.10), we get

$$\frac{\partial k_h^h}{\partial \rho_h^h \partial \phi} = - \frac{2}{(1 - t_h)\phi^3 f''(\phi k_h^h)} = - \frac{2}{\phi} \frac{\partial k_h^h}{\partial \rho_h^h} > 0. \qquad \text{(A.16)}$$

Finally, using (1.8a), (1.9), (A.14) and (A.16), we get

$$\begin{aligned}
\chi_5 &= \frac{t_h}{1 - t_h} r^2 (t_h - \tau^h) \frac{2}{\phi} \left[1 - (1 - \tau^h)(\lambda_h + \beta_h^h) + \frac{\delta}{2} \left(\beta_h^h \right)^2 \right] \frac{\partial k_h^h}{\partial \rho_h^h} \\
&- [(1 - \gamma) t_h + \gamma \tau^h] r \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi} < 0. \qquad \text{(A.17)}
\end{aligned}$$

[1]This is true if the production function is not too concave, i.e. f” is small.

$$\chi_6 = -\frac{t_h}{1-t_h} r^2 (\lambda_h + \beta_h^h) \frac{2}{\phi} \left[1 - (1-\tau^h)(\lambda_h + \beta_h^h) + \frac{\delta}{2} \left(\beta_h^h\right)^2 \right] \frac{\partial k_h^h}{\partial \rho_h^h}$$
$$+ \left[t_h \frac{r^2}{\delta} - \gamma(\lambda_h + \beta_h^h) r \right] \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi} > 0. \tag{A.18}$$

The signs of (A.3) are determined by the signs of the numerators. Using (A.8), (A.9), (A.10), (A.11), (A.17) and (A.18), we get for $\gamma = 0$

$$\chi_2\chi_6 - \chi_4\chi_5 = -\left(\frac{t_h}{1-t_h}\right)^2 r^4 \lambda_h \frac{2}{\phi} \Sigma \Psi \left(\frac{\partial k_h^h}{\partial \rho_h^h}\right)^2$$
$$- \frac{t_h}{1-t_h} r^2 \lambda_h \chi_5 \left[\lambda_h - \frac{r}{\delta}(1 - 2t_h + \tau^h) \right] \frac{\partial k_h^h}{\partial \rho_h^h}, \tag{A.19}$$

$$\chi_3\chi_5 - \chi_1\chi_6 = \left(\frac{t_h}{1-t_h}\right)^2 r^4 \frac{2}{\phi} (t_h - \tau^h) \Psi^2 \left(\frac{\partial k_h^h}{\partial \rho_h^h}\right)^2$$
$$+ \left(\frac{t_h}{1-t_h}\right)^2 r^4 \frac{2}{\phi} (t_h - \tau^f)[(1-t_h) + (1-\tau^f)](\lambda_h + \beta_h^f) \Psi \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\partial k_h^f}{\partial \rho_h^f}$$
$$+ \frac{t_h^2}{1-t_h} r^3 \left[(1-\tau^h)\lambda_h \frac{\partial k_h^h}{\partial \rho_h^h} - \frac{r}{\delta}(t_h - \tau^f)[(1-t_h) + (1-\tau^f)] \frac{\partial k_h^f}{\partial \rho_h^f} \right] \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi}$$
$$+ \frac{t_h^2}{1-t_h} r^4 \frac{2}{\phi} (t_h - \tau^h) \lambda_h \Psi \left(\frac{\partial k_h^h}{\partial \rho_h^h}\right)^2 - \frac{t_h^2}{1-t_h} r^3 \Psi \frac{\partial k_h^h}{\partial \rho_h^h} \frac{\mathrm{d}k_h^h}{\mathrm{d}\phi}, \tag{A.20}$$

where $\Sigma = 1 - 2(1-\tau^h)(\lambda_h + \beta_h^h) - (1-t_h)\beta_h^h + \frac{\delta}{2}\left(\beta_h^h\right)^2 < 0$ if δ is small and $\Psi = 1 - (1-\tau^h)(\lambda_h + \beta_h^h) + \frac{\delta}{2}\left(\beta_h^h\right)^2 > 0$.

In equation (A.19) the first term on the right-hand side is positive. The sign of the second term is ambiguous. For $t_h < 0.5$, $(1 - 2t_h + \tau^h)$ is positive. If δ is small, the term in squared brackets becomes negative, and thus the second term of the right-hand side becomes positive, so that $\chi_2\chi_6 - \chi_4\chi_5 > 0$.

In (A.20) the first, the second and the fourth term on the right-hand side are positive. The sign of the third term is ambiguous. Again, if δ is small this term becomes positive, so that $\chi_3\chi_5 - \chi_1\chi_6 > 0$.

Hence, a greater home bias results in a more generous thin capitalization rule and a stricter CFC rule, i.e.

$$\frac{\mathrm{d}\lambda_h}{\mathrm{d}\phi} > 0, \quad \frac{\mathrm{d}\tau^h}{\mathrm{d}\phi} > 0. \tag{A.21}$$

B Appendix to Chapter 2

First-best optimal investment for the subsidiaries is implicitly given by the condition

$$\theta^j f'(K^j(\theta^j)) - i = 0. \tag{B.1}$$

The explicit optimal amount of capital invested then is

$$K^j = f'^{-1}\left(\frac{i}{\theta^j}\right). \tag{B.2}$$

The difference in the first-best optimal amount of capital invested by the highly productive and the less productive subsidiaries is

$$\bar{K}^* - \underline{K}^* = f'^{-1}\left(\frac{i}{\bar{\theta}}\right) - f'^{-1}\left(\frac{i}{\underline{\theta}}\right). \tag{B.3}$$

Following (2.5) constrained investment for the low-productivity subsidiaries $\underline{K}$ is determined by

$$\underline{V}_1 = \beta\underline{K} - r(\underline{I} + E) + pt_1 i\underline{\omega} \tag{B.4}$$

and analogously for the high-productivity subsidiaries by

$$\bar{V}_1 = \beta\bar{K} - r(\bar{I} + E) + pt_1 i\bar{\omega}. \tag{B.5}$$

Subtracting (B.4) from (B.5) gives the difference in the amount of capital in the constrained equilibrium that is invested by the two types of subsidiaries

$$\bar{K} - \underline{K} = \frac{1}{\beta}\left(\bar{V}_1 - \underline{V}_1 + r(\bar{I} - \underline{I}) - pt_1 i(\bar{\omega} - \underline{\omega})\right). \tag{B.6}$$

Hence, the difference between optimal investment and constrained investment is relatively higher for the highly productive subsidiaries if

$$\bar{K}^* - \underline{K}^* > \bar{K} - \underline{K} \quad \Leftrightarrow \quad \beta > \frac{\bar{V}_1 - \underline{V}_1 + r(\bar{I} - \underline{I}) - pt_1 i(\bar{\omega} - \underline{\omega})}{f'^{-1}(i/\bar{\theta}) - f'^{-1}(i/\underline{\theta})} > 0. \tag{B.7}$$

C Appendix to Chapter 3

C.1 Derivation of the ex-post optimal abusive transfer prices

Differentiating the concealment cost function given in equation (3.9), we get as marginal concealment costs for manipulating the transfer prices of the licence fee and the intermediate input good, respectively,

$$\frac{\partial C^P}{\partial P_i^X} = \left[\frac{\eta_X}{2}\left(P_i^X\right)^2 + \frac{\eta_S}{2}\left(P_i^S\right)^2\right]\eta_X P_i^X, \tag{C.1}$$

$$\frac{\partial C^P}{\partial P_i^S} = \left[\frac{\eta_X}{2}\left(P_i^X\right)^2 + \frac{\eta_S}{2}\left(P_i^S\right)^2\right]\eta_S P_i^S. \tag{C.2}$$

By equating the two expressions (C.1) and (C.2), we find an 'inverse-cost rule' for transfer-pricing devices,[1]

$$\frac{P_i^S}{P_i^X} = \frac{\eta_X}{\eta_S}, \tag{C.3}$$

Relying on equation (C.3) in order to substitute for P_i^S in equations (C.1) and using (3.4b) leads to the optimal (abusive) transfer prices in the case of a profitable affiliate

$$\left(G_i^X\right)^* = \sqrt[3]{\frac{\eta_S}{\eta_S + \eta_X} \cdot \frac{2}{(\eta_X)^2} \cdot (\mathbb{1} \cdot t_i - t_1)}\ \frac{1}{\bar{X}}. \tag{C.4}$$

Analogous, we can determine the optimal transfer price for the intermediate good and get

$$\left(G_i^S\right)^* = \sqrt[3]{\frac{\eta_X}{\eta_S + \eta_X} \cdot \frac{2}{(\eta_S)^2} \cdot (\mathbb{1} \cdot t_i - t_1)}\ \frac{1}{S_i}. \tag{C.5}$$

C.2 Derivation of the first-order conditions for ex-ante tax-planning

In the following, we exemplarily deliver the first-order condition for the licence-fee transfer price in the case that all tax-planning decisions need to be taken ex-ante (i.e.,

[1] Note that, in the optimum, marginal concealment costs will be equalized for both transfer-pricing strategies.

before the true sales price is revealed). This first-order condition is given by

$$\begin{aligned}\frac{\partial E(\Pi)}{\partial G_i^X} &= -\bar{X} + (1 - H(p_i^0))t_i\bar{X} - \frac{\partial C^P}{\partial P_i^X}\bar{X} + (1 - t_1)\bar{X} + h(p_i^0)t_i p_i^0 y_i \frac{\partial p_i^0}{\partial G_i^X} \\ &- h(p_i^0)t_i[(G_i^X + q_X)\bar{X} + (G_i^S + q_S)S_i + rb_iK_i]\frac{\partial p_i^0}{\partial G_i^X} = 0. \qquad (C.6)\end{aligned}$$

Rearranging the terms gives

$$\begin{aligned}&\left[(1 - H(p_i^0))t_i - t_1 - \frac{\partial C^P}{\partial P_i^X}\right]\bar{X} \\ -\ &h(p_i^0)t_i[p_i^0 y_i - (G_i^X + q_X)\bar{X} - (G_i^S + q_S)S_i - rb_iK_i]\frac{\partial p_i^0}{\partial G_i^X} = 0. \qquad (C.7)\end{aligned}$$

Recall that the price p_i^0 is defined as the price for which taxable profits are zero. Hence, the term in the second line vanishes as the value of the squared brackets is zero. Therefore, we get

$$[1 - H(p_i^0)]t_i - t_1 = \frac{\partial C^P}{\partial P_i^X}. \qquad (C.8)$$

C.3 Simultaneity bias

Our aim is to estimate the effect from being in a loss position (dummy $L_{it} = 1$ if firm i experiences a loss in year t, zero otherwise) on transfer payments and internal leverage on internal debt in year t, y_{it}. z_{it} is an exogenous control variable (or a vector of such) that is potentially correlated with both y_{it} and the probability of experiencing a loss.

$$y_{it} = \alpha_1 L_{it} + \beta_{10} + \beta_{11} z_{it} + u_{1it},\ \ \alpha_1 < 0 \qquad (C.9)$$

The problem is that reducing outgoing transfer prices and/or lowering internal leverage also lowers the probability of experiencing losses. We thus also have the following relationship

$$L_{it} = \alpha_2 y_{it} + \beta_{20} + \beta_{22} z_{it} + u_2,\ \ 0 > \alpha_2 \qquad (C.10)$$

This is an example of two-way causality, both variables have an effect on the other. (C.9) and (C.10) present the model on structural form. The reduced form presentation is found by solving the system for the two endogenous variables and finding quantity and price as functions of the exogenous variable(s). The solution for transfer payments/internal debt/interest payments is then given by

$$y_{it} = \underbrace{\frac{\beta_{10} - \alpha_1 \beta_{20}}{1 - \alpha_1 \alpha_2}}_{\pi_{10}} + \underbrace{\frac{\beta_{11} - \beta_{22}}{1 - \alpha_1 \alpha_2}}_{\pi_{11}} z_{it} + \underbrace{\frac{u_{1it} - \alpha_1 u_{2it}}{1 - \alpha_1 \alpha_2}}_{e_{1it}}$$

By introducing some auxiliary notation, this reduces to

$$y_{it} = \pi_{10} + \pi_{11} z_{it} + e_{1it} \tag{C.11}$$

Similarly, we find the solution for the loss position dummy as

$$L_{it} = \underbrace{\frac{\beta_{20} + \alpha_2 \beta_{10}}{1 - \alpha_1 \alpha_2}}_{\pi_{20}} - \underbrace{\frac{\beta_{11} + \beta_{22}}{1 - \alpha_1 \alpha_2}}_{\pi_{21}} z_{it} + \underbrace{\frac{u_{2it} + \alpha_2 u_{1it}}{1 - \alpha_1 \alpha_2}}_{e_{2it}}$$

Again, auxiliary notation helps to make the notation more compact

$$L_{it} = \pi_{20} + \pi_{21} z_{it} + e_{2it} \tag{C.12}$$

(C.11) and (C.12) give the reduced form presentation of the model, since transfer prices and loss position are given as functions only of exogenous variables.

In this paper, we estimate the structural equation (C.9). The problem by estimating this directly is that L_{it} is endogenously decided within the model and thus correlated with the error term u_{1it}. The covariance between L_{it} and u_{1it} is

$$\text{cov}\left(L_{it},\, u_{1it}\right) = E\left[\left(\pi_{20} + \pi_{21} z_{it} + e_{2it}\right) u_{1it}\right] = E\left(e_{2it} u_{1it}\right)$$

since the z-variable(s) is/are exogenous. If we insert for e_{2it}, and assume that u_{1it} and u_{2it} are uncorrelated, we get

$$\text{cov}\left(L_{it},\, u_{1it}\right) = E\left(\frac{u_2 + \alpha_2 u_1}{1 - \alpha_1 \alpha_2} u_1\right) = \frac{\alpha_2 \sigma_1^2}{1 - \alpha_1 \alpha_2} > 0 \tag{C.13}$$

since $\alpha_2 > 0$, and $1 - \alpha_1 \alpha_2 > 0$. $\sigma_1^2 = E\left(u_{1it}^2\right)$, the variance of u_1, assuming homoscedasticity. Importantly, OLS is likely to give a positive bias in the estimator for α_1. Keep in mind that this is negative, meaning that OLS will underestimate the effect from losses on transfer payments/internal leverage.

C.4 Descriptive statistics II: Control variables

	Mean	(st.dev)
Tax rate for affiliate with lowest tax rate ($N = 8,091$)	0.27	(0.09)
Results as share of total assets ($N = 39,141$)	-0.09	(0.68)
Total assets (in 1,000 NOK) ($N = 39,362$)	63,140	(108,168)
Employees ($N = 38,108$)	19.98	(35.48)
Company age ($N = 40,079$)	13.30	(15.86)
Loss carry forward as share of result ($38,552$)	0.01	(0.59)

The sample is the Norwegian based MNCs. Results as share of total assets, total assets, and employees are winsorized at the 1st percentile.

D Appendix to Chapter 4

D.1 Deriving the multiplier ϕ

Totally differentiating (4.6) with respect to α gives

$$\frac{\partial B_i}{\partial \alpha} + \frac{\partial B_i}{\partial t_i}\frac{\mathrm{d}t_i}{\mathrm{d}\alpha} + \frac{\partial B_i}{\partial t_j}\frac{\mathrm{d}t_j}{\mathrm{d}\alpha} + t_i\left(\frac{\partial \Omega_i}{\partial \alpha} + \frac{\partial \Omega_i}{\partial t_i}\frac{\mathrm{d}t_i}{\mathrm{d}\alpha} + \frac{\partial \Omega_i}{\partial t_j}\frac{\mathrm{d}t_j}{\mathrm{d}\alpha}\right) + \Omega_i\frac{\mathrm{d}t_i}{\mathrm{d}\alpha} = 0.$$

Rearranging the terms and using the symmetry condition $\left(\frac{\mathrm{d}t_i}{\mathrm{d}\alpha} = \frac{\mathrm{d}t_j}{\mathrm{d}\alpha} = \frac{\mathrm{d}t}{\mathrm{d}\alpha}\right)$ leads to

$$\frac{\partial B_i}{\partial \alpha} + t_i\frac{\partial \Omega_i}{\partial \alpha} + \left(\Omega_i + \frac{\partial B_i}{\partial t_i} + \frac{\partial B_i}{\partial t_j} + t_i\frac{\partial \Omega_i}{\partial t_i} + t_i\frac{\partial \Omega_i}{\partial t_j}\right)\frac{\mathrm{d}t}{\mathrm{d}\alpha} = 0. \tag{D.1}$$

Introducing

$$\phi \equiv -\left(\Omega_i + \frac{\partial B_i}{\partial t_i} + \frac{\partial B_i}{\partial t_j} + t_i\frac{\partial \Omega_i}{\partial t_i} + t_i\frac{\partial \Omega_i}{\partial t_j}\right) \tag{D.2}$$

gives equation (4.8) in the main text.

D.2 Signing the multiplier ϕ

Benchmark scheme. To sign ϕ in (D.2) under the benchmark scheme, we first differentiate eq. (4.3), treating f_{kk} as a constant for analytical simplicity:[1]

$$\frac{\partial^2 k_i}{\partial t_i^2} = 0, \quad \frac{\partial^2 k_j}{\partial t_i^2} = \frac{2(1-\alpha t_j)(1-p)}{p(1-t_i)^3 f_{kk}}, \quad \frac{\partial^2 k_j}{\partial t_j \partial t_i} = \frac{-\alpha(1-p)}{p(1-t_i)^2 f_{kk}}. \tag{D.3}$$

Using the symmetry condition along with eqs. (4.2), (4.3), and (4.7) gives:

$$\begin{aligned}
\phi &= -\frac{(1-p)^2(1-\alpha t)^2}{p(1-t)^3 f_{kk}} - \frac{(1-p)^2\alpha^2}{p(1-t)f_{kk}} + \frac{2\alpha(1-p)^2(1-\alpha t)}{p(1-t)^2 f_{kk}} \\
&- \frac{3t(1-p)^2(1-\alpha t)}{p(1-t)^4 f_{kk}} + \frac{2\alpha(1-p)^2(1-\alpha t)}{p(1-t)^3 f_{kk}} - \frac{\alpha(1-p)^2}{p(1-t)^2 f_{kk}} \\
&= -\frac{(1-p)^2}{p(1-t)^4 f_{kk}}[2(1-\alpha t)^2(1-t) + 2\alpha^2(1-t)^3 - 2\alpha(1-\alpha t)(1-t)^2 \\
&+ 3t(1-\alpha t) - 2\alpha t(1-\alpha t)(1-t) + \alpha t(1-t)^2]
\end{aligned}$$

[1] See footnote 15 in the main text for further discussion.

Rearranging terms and simplifying, we finally get

$$\begin{aligned}\phi &= -\frac{(1-p)^2}{p(1-t)^4 f_{kk}}[2(1-\alpha)(1-\alpha t)(1-t) + 2\alpha^2(1-t)^3 + \alpha t(1-t)^2 \\ &+ 2\alpha t^2(1-\alpha t) + (3-2\alpha)t(1-\alpha t)] > 0, \qquad \text{(D.4)}\end{aligned}$$

which is unambiguously positive.

Alternative scheme. Analogously to (D.2), the multiplier $\tilde{\phi}$ is defined as

$$\tilde{\phi} \equiv -\left(\tilde{\Omega}_i + \frac{\partial \tilde{B}_i}{\partial \tilde{t}_i} + \frac{\partial \tilde{B}_i}{\partial \tilde{t}_j} + \tilde{t}_i \frac{\partial \tilde{\Omega}_i}{\partial \tilde{t}_i} + \tilde{t}_i \frac{\partial \tilde{\Omega}_i}{\partial \tilde{t}_j}\right). \qquad \text{(D.5)}$$

To sign $\tilde{\phi}$, we derive from (4.22) (assuming, as before, that f_{kk} is a constant):

$$\frac{\partial^2 \tilde{k}_j}{\partial \tilde{t}_i \partial \tilde{t}_j} = 0, \quad \frac{\partial^2 \tilde{k}_j}{\partial \tilde{t}_i^2} = \frac{2(1-\alpha)(1-p)}{p(1-\tilde{t}_i)^3 f_{kk}}. \qquad \text{(D.6)}$$

Using (4.21), (4.22), and (4.24) gives:

$$\tilde{\phi} = -\frac{2(1-p)^2(1-\alpha)(1-\alpha\tilde{t}_i)}{p(1-\tilde{t}_i)^3 f_{kk}} - \frac{(1-p)^2(1-\alpha)^2\tilde{t}_i}{p(1-\tilde{t}_i)^4 f_{kk}} - \frac{2(1-p)^2(1-\alpha)(1-\alpha\tilde{t}_i)\tilde{t}_i}{p(1-\tilde{t}_i)^4 f_{kk}}. \qquad \text{(D.7)}$$

After rearranging terms, we finally get

$$\tilde{\phi} = -\frac{(1-\alpha)(1-p)^2}{p(1-\tilde{t}_i)^4 f_{kk}}[2(1-\alpha\tilde{t}_i) + (1-\alpha)\tilde{t}_i] \geq 0. \qquad \text{(D.8)}$$

Benchmark scheme: Extension with home ownership of MNEs. The multiplier ϕ^W is defined analogously to (D.2). Using the symmetry condition, (4.2), (4.3), (4.7) and (4.34) gives, after rearranging terms:

$$\begin{aligned}\phi^W &= -\frac{(1-p)^2}{p(1-t^W)^4 f_{kk}}[2(1-\alpha)(1-\alpha t^W)(1-t^W) + (2-\lambda)\alpha^2(1-t^W)^3 \\ &+ \alpha t^W(1-t^W)^2 + 2\alpha(t^W)^2(1-\alpha t^W) + (3-2\alpha)t^W(1-\alpha t^W) \\ &+ \lambda\alpha(1-\alpha t^W)(1-t^W)^2] > 0. \qquad \text{(D.9)}\end{aligned}$$

D.3 The model with endogenous success probabilities of firms

Benchmark scheme. Totally differentiating the first-order conditions (4.2) and (4.37) leads to the following equation set:

$$\begin{bmatrix} \gamma_1 & \gamma_2 \\ \gamma_2 & \gamma_3 \end{bmatrix} \times \begin{bmatrix} \mathrm{d}k_i \\ \mathrm{d}p_i \end{bmatrix} = \begin{bmatrix} \gamma_4 \\ \gamma_5 \end{bmatrix} \mathrm{d}t_j + \begin{bmatrix} \gamma_6 \\ \gamma_7 \end{bmatrix} \mathrm{d}t_i, \tag{D.10}$$

where

$$\begin{aligned} \gamma_1 &= (1-t_j)p_i f_{kk} < 0, \qquad \gamma_2 = (1-t_j)[f_{k_i} - 1 + p_i f_{kp}] + 1 - \alpha t_i \\ \gamma_3 &= (1-t_j)(2f_{p_i} + p_i f_{pp}) < 0, \qquad \gamma_4 = p_i(f_{k_i} - 1) \geq 0 \\ \gamma_5 &= f(p_i, k_i) + p_i f_{p_i} - k_i < 0, \qquad \gamma_6 = -\alpha(1-p_i) \leq 0 \\ \gamma_7 &= \alpha k_i \geq 0 \end{aligned} \tag{D.11}$$

In this setting, the sign of γ_2 is ambiguous. We assume that a higher success probability reduces the marginal productivity of capital, implying $f_{kp} < 0$, and that this effect is sufficiently strong to make γ_2 negative. This is a sufficient, but not a necessary condition to unambiguously sign the comparative static effects that follow.

Applying Cramer's rule to the equation system (D.10), the effects of taxes on investment levels and success probabilities in each country can be signed as:

$$\frac{\mathrm{d}k_i}{\mathrm{d}t_i} = \frac{\gamma_3\gamma_6 - \gamma_2\gamma_7}{\gamma_1\gamma_3 - \gamma_2{}^2} > 0, \qquad \frac{\mathrm{d}k_i}{\mathrm{d}t_j} = \frac{\gamma_3\gamma_4 - \gamma_2\gamma_5}{\gamma_1\gamma_3 - \gamma_2{}^2} < 0, \tag{D.12}$$

$$\frac{\mathrm{d}p_i}{\mathrm{d}t_i} = \frac{\gamma_1\gamma_7 - \gamma_2\gamma_6}{\gamma_1\gamma_3 - \gamma_2{}^2} < 0, \qquad \frac{\mathrm{d}p_i}{\mathrm{d}t_j} = \frac{\gamma_1\gamma_5 - \gamma_2\gamma_4}{\gamma_1\gamma_3 - \gamma_2{}^2} > 0. \tag{D.13}$$

The effects on k_i in (D.12) correspond to the baseline model. Eq. (D.13) shows that an increase in country j's tax rate leads to the subsidiary of firm i choosing a higher success probability p_i. In contrast, an increase in the tax rate of country i decreases the optimal success probability by firm i's subsidiary when the loss offset parameter α is strictly positive.

The optimal tax rate is determined analogously to (4.8). We denote variables by a 'hat' symbol and assume the multiplier $\hat{\phi}$ to be positive. The change in country i's tax base following an increase in α is given by

$$\frac{\partial \hat{B}_i}{\partial \alpha} = -(1-p)k - \frac{(1-\alpha)(1-p)^2 t}{(1-t)\gamma_1} - \frac{(1-\alpha)k^2 t}{(1-t)\gamma_3}\,. \tag{D.14}$$

As in the benchmark model, the effect can only be signed when cross-border loss offset is almost complete ($\alpha \to 1$) and countries are symmetric. In this case all indirect effects operating through induced changes in k_i and p_i cancel out, leaving only the negative direct effect of α.

The effects of a change in α on $\hat{\Omega}_i$ are also ambiguous, in general. The total change is:

$$\begin{aligned}\frac{\partial \hat{\Omega}_i}{\partial \alpha} = {} & \frac{\partial \gamma_4}{\partial \alpha}\frac{\mathrm{d}k_j}{\mathrm{d}t_i} + \frac{\partial \gamma_5}{\partial \alpha}\frac{\mathrm{d}p_j}{\mathrm{d}t_i} + \frac{\partial \gamma_6}{\partial \alpha}\frac{\mathrm{d}k_i}{\mathrm{d}t_i} + \frac{\partial \gamma_7}{\partial \alpha}\frac{\mathrm{d}p_i}{\mathrm{d}t_i} + \gamma_4\frac{\partial(\mathrm{d}k_j/\mathrm{d}t_i)}{\partial \alpha} \\ & + \gamma_5\frac{\partial(\mathrm{d}p_j/\mathrm{d}t_i)}{\partial \alpha} + \gamma_6\frac{\partial(\mathrm{d}k_i/\mathrm{d}t_i)}{\partial \alpha} + \gamma_7\frac{\partial(\mathrm{d}p_i/\mathrm{d}t_i)}{\partial \alpha}.\end{aligned} \tag{D.15}$$

For $\alpha \to 1$, this expression can be unambiguously signed. Evaluating (D.15) at $\alpha = 1$ and using $\gamma_4|_{\alpha=1} = (1-p_i)$, $\gamma_5|_{\alpha=1} = -k_i$, $\gamma_6|_{\alpha=1} = -(1-p_i)$, $\gamma_7|_{\alpha=1} = k_i$ and the symmetry condition $t_i = t_j$ gives

$$\begin{aligned}\left.\frac{\partial \hat{\Omega}_i}{\partial \alpha}\right|_{\alpha=1} = {} & \frac{-4t_i\gamma_2}{N^2}\{[(1-p_i)\gamma_3 + k_i\gamma_2] + [k_i\gamma_1 + (1-p_i)\gamma_2]\} \\ & + \frac{(1-p_i)\gamma_3 + k_i\gamma_2}{N}\left[\frac{2-3t_j}{1-t_j}(1-p_i) + \frac{(\gamma_2 + 1 - t_j)t_j k_i}{(1-t_j)\gamma_3}\right] \\ & + \frac{k_i\gamma_1 + (1-p_i)\gamma_2}{N}\left[\frac{2-3t_j}{1-t_j}\,k_i + \frac{(\gamma_2 + 1 - t_j)t_j(1-p_i)}{(1-t_j)\gamma_1}\right],\end{aligned} \tag{D.16}$$

where $N = \gamma_1\gamma_3 - \gamma_2^2 > 0$. A sufficient condition for the terms in squared brackets, and therefore for the entire derivative, to be negative is that $t_j \leq 2/3$. Hence we get:

$$\left.\frac{\mathrm{d}\hat{\Omega}_i}{\mathrm{d}\alpha}\right|_{\alpha=1} < 0 \quad \Leftrightarrow \quad t \leq \frac{2}{3}. \tag{D.17}$$

In comparison to the benchmark model [eq. (4.12)] the range of tax rates for which Proposition 1a obtains is thus enlarged, due to the endogenous choice of firms' success probabilities.

To analyze the total change in equilibrium tax revenues, we need to determine the tax externality. This is given by

$$\frac{\partial \hat{T}_i}{\partial t_j} = t_i \left[\gamma_4 \frac{\mathrm{d}k_j}{\mathrm{d}t_j} + \gamma_5 \frac{\mathrm{d}p_j}{\mathrm{d}t_j} + \gamma_6 \frac{\mathrm{d}k_i}{\mathrm{d}t_j} + \gamma_7 \frac{\mathrm{d}p_i}{\mathrm{d}t_j} \right] > 0. \qquad \text{(D.18)}$$

As in the baseline model, the tax externality is positive, implying that Proposition 1c carries over to this model extension. In comparison to the baseline model, a rise in t_j further expands country i's expected tax base through a lower success probability, but a higher expected return, chosen by the subsidiary of firm j. Moreover, the subsidiary of firm i chooses a higher success probability and this reduces the expected tax rebates that have to be paid by country i's government.

Alternative scheme. Totally differentiating the first-order conditions under the alternative scheme, eqs. (4.21) and (4.38), gives the equation set:

$$\begin{bmatrix} \bar{\gamma}_1 & \bar{\gamma}_2 \\ \bar{\gamma}_2 & \bar{\gamma}_3 \end{bmatrix} \times \begin{bmatrix} \mathrm{d}k_i \\ \mathrm{d}p_i \end{bmatrix} = \begin{bmatrix} \bar{\gamma}_4 \\ \bar{\gamma}_5 \end{bmatrix} \mathrm{d}t_j, \qquad \text{(D.19)}$$

where variables for the alternative scheme are indicated by a bar and

$$\begin{aligned} \bar{\gamma}_1 &= (1-t_j)p_i f_{kk} < 0, \qquad \bar{\gamma}_2 = (1-t_j)[f_{k_i} - 1 + p_i f_{kp}] + 1 - \alpha t_j < 0 \\ \bar{\gamma}_3 &= (1-t_j)(2f_{p_i} + p_i f_{pp}) < 0, \qquad \bar{\gamma}_4 = (1-p_i)(1-\alpha)/(1-t_j) \geq 0, \\ \bar{\gamma}_5 &= -(1-\alpha)k_i/(1-t_j) \leq 0. \end{aligned} \qquad \text{(D.20)}$$

Following (4.8), we assume that $\bar{\phi} > 0$. The effect of α on country i's tax base is given by

$$\frac{\partial \bar{B}_i}{\partial \alpha} = -\frac{(1-p)^2(1-\alpha t)t}{(1-t)\bar{\gamma}_1} - \frac{k^2(1-\alpha t)t}{(1-t)\bar{\gamma}_3} > 0. \qquad \text{(D.21)}$$

The effect of an increase in α on $\bar{\Omega}_i$ is

$$\begin{aligned} \frac{\partial \bar{\Omega}_i}{\partial \alpha} =& -\frac{(1-\alpha)t + (1-\alpha t)]k^2}{(1-t)^2\bar{N}}\bar{\gamma}_1 - \frac{2(1-p)k[t + (1-\alpha t)\bar{N}]}{(1-t)^2\bar{N}}\bar{\gamma}_2 \\ & - \frac{(1-p)^2[(1-\alpha)t + (1-\alpha t)]}{(1-t)^2\bar{N}}\bar{\gamma}_3 - \frac{2(1-\alpha)(1-\alpha t)tk}{(1-t)^2\bar{N}^2}\bar{\gamma}_1\bar{\gamma}_2 \\ & - \frac{2(1-\alpha)(1-\alpha t)t(1-p)^2}{(1-t)^2\bar{N}^2}\bar{\gamma}_3\bar{\gamma}_2 - \frac{4(1-\alpha)(1-\alpha t)(1-p)tk}{(1-t)^2\bar{N}}\bar{\gamma}_2^2 \\ & - \frac{(1-p)(1-\alpha)(1-\alpha t)(1+t)k}{(1-t)^2\bar{N}}, \end{aligned} \qquad \text{(D.22)}$$

with $\bar{N} = \bar{\gamma}_1\bar{\gamma}_3 - \bar{\gamma}_2^2 > 0$. The first three terms on the right hand side of (D.22) are positive, the last four are negative. However, if cross-border loss offset is almost complete ($\alpha \to 1$), these effects are negligible. Hence, for $\alpha \to 1$, the total effect on $\bar{\Omega}_i$ is positive and therefore also the overall effect of α on the tax rate.

Finally, deriving the tax externality by analogy to (4.28) gives

$$\frac{\partial \bar{T}_i}{\partial t_j} = \frac{\alpha}{(1-\alpha t)} \left[(1-t)\bar{B}_i - (1-\alpha t)(1-p)k\right] \geq 0, \tag{D.23}$$

where $\bar{B}_i$ is given in (D.21). Hence tax revenues unambiguously rise in both countries when $dt_i/d\alpha$ is positive.

D.4 Simulation results for asymmetric countries

Table D.1: Cross-border loss compensation with asymmetric countries

	benchmark scheme				alternative scheme				mixed scheme			
α	t_1	t_2	T_1	T_2	t_1	t_2	T_1	T_2	t_1	t_2	T_1	T_2
0.0	0.33	0.41	3.89	5.55	0.33	0.41	3.89	5.55	0.33	0.41	3.89	5.55
0.2	0.32	0.38	4.20	5.54	0.37	0.43	4.13	5.89	0.35	0.41	4.16	5.73
0.4	0.29	0.33	4.13	5.20	0.41	0.46	4.45	6.35	0.36	0.41	4.40	5.89
0.6	0.24	0.27	3.42	4.23	0.48	0.54	4.88	7.00	0.36	0.41	4.55	5.88
0.8	0.17	0.19	2.20	2.78	0.58	0.63	5.58	8.12	0.35	0.41	4.53	5.47
1.0	0.11	0.13	1.09	1.46	0.68*	0.71*	6.20*	9.16*	0.32	0.41	4.29	4.59

Notes: $\overline{G}_1 = 0.5$, $\overline{G}_2 = 5.0$; $A = 5$, $\varepsilon = 0.8$, $p = 0.5$.
* values for $\alpha = 0.9$ (no interior solution for $\alpha = 1$)

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